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A COMPARISON OF THE DIAGENETIC AND DIAGNOSTIC FEATURES OF THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT REEF COMPLEXES

G. A. LESLIE

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Thesis
1955
#17

"A COMPARISON OF THE DIAGENETIC AND DIAGNOSTIC FEATURES OF THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT REEF COMPLEXES."

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BY

Gordon Anthony Leslie, B. Sc.

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ABSTRACT

Investigations of the chemical composition, diagenetic changes and fossil remains have been conducted on cores and cuttings samples from the Sturgeon Lake, Normandville and Clairmont Upper Devonian reef complexes. By integrating the results obtained with regional stratigraphic features, suggestions are postulated as to the basinal orientation of the reefs and their tectonic history.

It is apparent that reefs developed at Sturgeon Lake and Normandville on gently subsiding platforms in clear, shallow basinal environments. The Sturgeon Lake reef complex, which is remarkably thick, massive and homogeneous lithologically, is indicative of stable conditions during deposition; in contrast to the less stable conditions indicated by cyclic phases of deposition in the Normandville complex. The diagenetic features of the Clairmont and western off reef Sturgeon Lake sediments suggest a stable shelf or a restricted back reef depositional environment.

Reef development appears to have been abruptly terminated by a major diastrophic event, followed by undulating platform conditions. A slight pivoting about the Peace River high and moderate tilting into the Cordilleran geosyncline was the final tectonic stage in the orientation of the reefs.

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CHAPTER 1

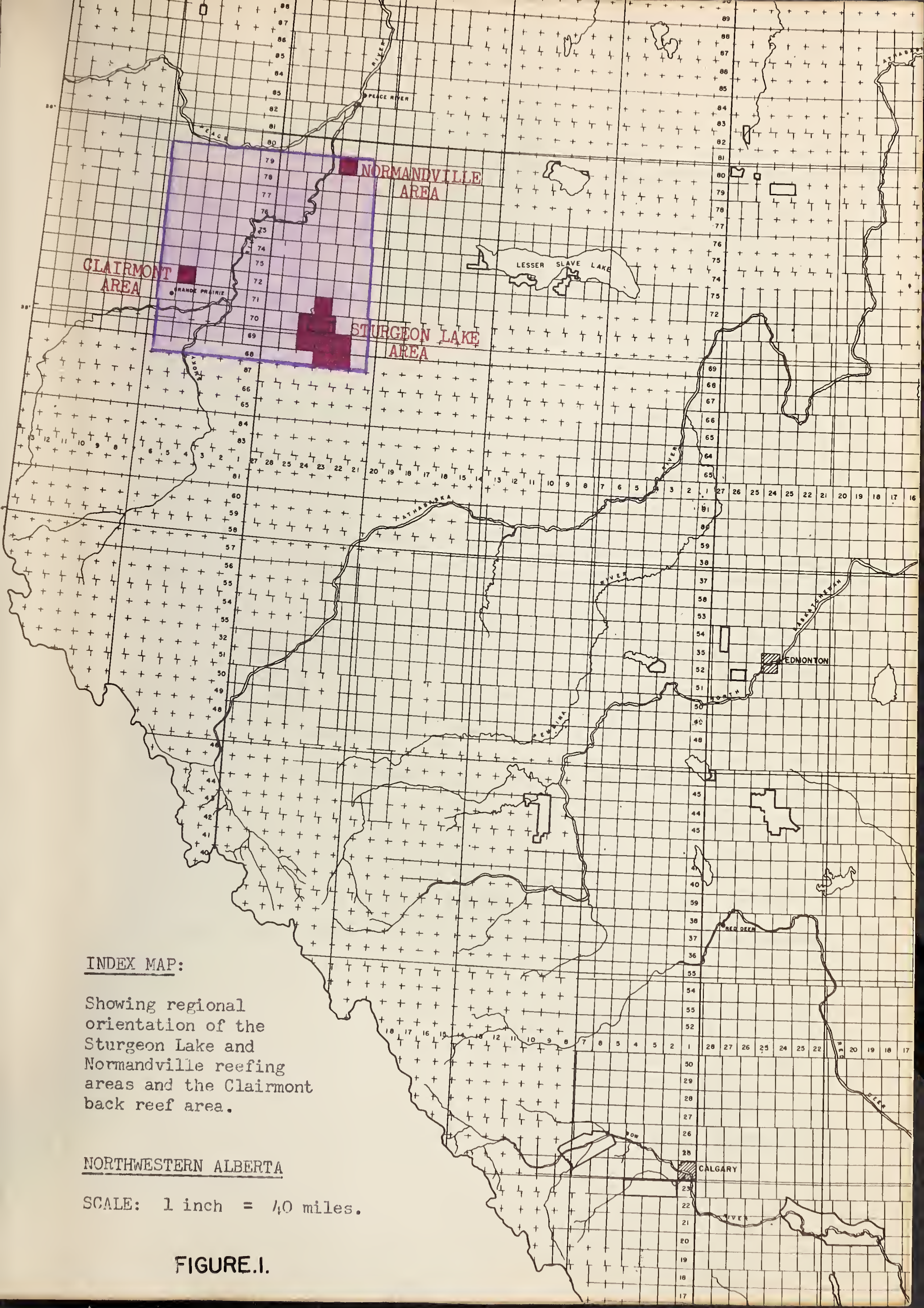
INTRODUCTION

General Statement

Since oil was discovered in the Sturgeon Lake area by the drilling of the Amerada Crown "O" F33-32 well in May of 1952, considerable controversy has resulted throughout the industry as to the association or disassociation of the Sturgeon Lake, Normandville and Clairmont reef complexes. Controversial also, is whether they embody a continuous reef mass or whether Clairmont and Normandville are part of a large fringing reef around the Peace River Pre-Cambrian high with Sturgeon Lake constituting an independent barrier reef in the deeper regions of the Woodbend (Ireton) green shale basin. Another trend of thought is that the Sturgeon Lake complex, lacking in evidence of organic origin, is merely a facies change in the Ireton green shale sediments resulting from chemical deposition rather than a true biohermal reef development.

It was hoped by the author that, by applying quantitative laboratory techniques to the study of these complexes, it could be established whether they were actual biohermal reef masses of organic origin and if the complexes held a common basis for correlation. Also, suitable techniques were sought which would reveal their diagenetic history.

An index map is presented (see Figure 1, following p. 1) showing regional orientation of the above areas of reef development.



INDEX MAP:

Showing regional orientation of the Sturgeon Lake and Normandville reefing areas and the Clairmont back reef area.

NORTHWESTERN ALBERTA

SCALE: 1 inch = 40 miles.

FIGURE.I.

Methods of Investigation

Considering the physical and chemical processes due to environment which are involved in the deposition of sediments and considering the constituents of the sediments to be investigated, laboratory methods were sought which would prove most suitable to a diagenic study of the reef complexes.

Since a deficiency of fossil evidence and heavy minerals was anticipated in the sediments concerned, a quantitative chemical investigation of soluble and insoluble components, in addition to a microscopic study of the structural and textural features, was considered to be the most practical approach to a study of their diagenic history.

The chemical composition of the marine environment during deposition should be transmitted throughout the sediments. A quantitative determination of the mineral components should serve, along with an analysis of the insoluble residues, as an indication to the sedimentary environment. A quantitative chemical investigation of the major constituents of the sediments and insoluble residues was therefore undertaken for the determination of limestone, dolomite, anhydrite and pyrite.

The character and history of a sediment is also revealed in a study of its textures and structures. The texture or fabric of a sediment refers to its physical make-up as distinct from its mineral or chemical composition.

Variations in the chemical and mineral composition, textural differences and other morphological features produce structures. Structures can be mechanical, chemical or organic in origin and are indicative of the environmental conditions of deposition and to the effects of tectonic forces. A study of the textural and structural features of the sediments was undertaken from polished and thin sections of representative samples.

Various staining techniques have found practical application in the study of textures and structures by previous investigators. The Otto potassium chromate stain, as detailed by Krumbein and Pettijohn (1938), was employed in the study of the polished sections to intensify the textural, structural and fossil remnant features.

It was attempted, therefore, to unveil the diagenetic history of the Sturgeon Lake, Normandville and Clairmont reef complexes through a study of their chemical composition, insoluble residues, textures, structures and fossil remnants.

Definition of Diagenesis

Diagenesis, as defined by Twenhofel (1939), and cited by Krumbein (1942), is as follows:

> "Diagenesis includes all modifications that sediments undergo between deposition and lithification under conditions of pressure and temperature that are normal to the surface or outer part of the crust and, in addition, those changes that take place after lithification under the same conditions of temperature and pressure which are not katamorphic in character so that their effect is delithification."

This definition embodies modifications previous to advanced sedimentary lithification and also includes the relations of sediments to organisms and to sedimentary environment.

Definition of an Organic Reef

W. H. Twenhofel (1950) defined an organic reef as follows:

> "An organic reef or bioherm is an aggregate of organic materials of significant dimensions built in part by colonial organisms, mainly, but not necessarily marine, that lived near, but below the surface of the water (there may have been some exposure at low tide) and constructed of exoskeletal matter that became more or less adherent to previously formed similar matter. Nooks and depressions between the structures made by the colonial organisms, which may have as much space as, or greater than, the structures made by them, formed excellent dwelling places for non-colonial organisms which sought these places for protection or food. Organic reefs develop large vertical dimensions as compared with dimensions of adjacent contemporaneous deposits. Organisms which are responsible for this somewhat rigid framework of a reef are permanent dwellers on it and their exoskeletons remain to take a part in it after their deaths. As the structure, developed by the building of forming organisms, has a considerable rigidity it does not change volume under the weight of an overburden placed upon it. In a sense the complete structure is reinforced by the overlapping colonial growths and this reinforcement enables the accumulation to grow upward and at much steeper angles than is possible for most sedimentary materials and certainly for all clastic materials. Inclinations beyond the vertical are, therefore, possible. Contacts of a reef with marginal sediments are irregular and at angles that are not possible with ordinary sediments."

The favorable environmental conditions for vigorous reef development are worthy of mention because of their direct effect upon diagenetic processes. These general conditions are as follows:

1. Continuous submergence contemporaneous with reef

build-up (except for spasmodic emergence, during tides, for example).

2. Suitable salinity and water temperature for the propagation of reefal organisms.
3. Clear, placid waters providing an atmosphere free of marine muds, containing free oxygen and transmitting sunlight which is essential to the sustenance of certain organisms; particularly the algae.
4. The depth of water favoring reef growth is generally considered to be less than 200 feet due to the reefal organisms' demand for sunlight, free oxygen and restricted temperatures.

Within the perimeter of these definitions a study of the diagenetic history of the Sturgeon Lake, Normandville and Clairmont sediments was undertaken.

Previous Work

Although considerable exploration has been conducted in northwestern Alberta, and some general geological concepts have been formulated and published, little detailed work has been published on these specific areas. Those authors who have contributed to a knowledge of the general tectonics and geology of the areas are mentioned in the ensuing discussion.

In Webb's (1951) summary report of the geological history of the Western Canada plains, an outline of the general tectonics of Northwestern Alberta was included and

reference made also, to the stratigraphy and stratigraphic relationships in the area.

Belyea (1952), in her notes on the Devonian system of the north-central plains of Alberta, made certain interpretations of the stratigraphy of the general area with particular emphasis on facies changes.

An isopach map and facies study of the Elk Point formation was published by Workman (1953), which, in addition, outlined the tectonics of Northwestern Alberta at the end of Elk Point time.

Wonfor and Andrichuk (1953), in their report of the Stettler area, extended their discussion of the Devonian geological history to include the northwestern plains area of Alberta during Upper Devonian time.

A brief discussion of the influence of the Peace River high on the configuration of the Ireton green shale basin was presented by Storey (1953) with an accompanying map of the general structural framework of the basin.

In their zonation and discussion of the diastrophic significance of certain Devonian fauna, Warren and Stelck (1954) suggested a sequence of tectonic events based on faunal implications, which are applicable to reefing conditions in the Ireton green shale basin of the areas concerned.

In their discourse on Devonian reef distribution in Alberta, Downing and Cooke (1954), referred to the areal extent of reef development as effected by the Peace River

land mass and other reefal platforms.

Newland (1954) interpreted reef development in Alberta in respect to basinal configurations and facies changes. General reference was also made to the shelf and platform areas which favored reefing conditions.

Acknowledgments

The preparation of this thesis was under the direction of Dr. C. P. Gravenor to whom the writer owes particular gratitude for his helpful criticism and guidance.

Extensive assistance was rendered by Dr. C. R. Stelck concerning problems of fossil reconstruction from their altered host rock and their subsequent identification.

The cores of the Clairmont and Normandville wells were provided for study by Mr. G. Darling, Dr. P. Cote and Mr. G. McCallum of Imperial Oil Limited.

The cores, samples and electrologs of the Sturgeon Lake wells were made available by Mr. A. T. Jacobson and Mr. S. J. Kidd of Amerada Petroleum Corporation. The writer wishes to further express his appreciation to Mr. Kidd for his personal assistance given in the solution of numerous problems which were encountered in the course of this work.

Dr. W. E. Harris of the Chemistry Department suggested the Versenate Method for calcium and magnesium

determinations which proved to be a most useful technique. He also served the author as a patient consultant in various phases of chemistry.

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CHAPTER 2

STRATIGRAPHY OF THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT AREAS

General Stratigraphy

The generally accepted Upper Devonian correlations of the central plains and Northwestern Alberta sections with the Jasper type section is outlined by Storey (1953) as follows:

JASPER TYPE SECTION		CENTRAL PLAINS AND N.W. ALBERTA	
Formation	Formation	Formation	Member
PALLISER	COSTIGAN	WABAMUN FORMATION	D 1
	MORRO		
	ALEXO	WINTERBURN FORMATION	Graminia
			Calmar
FAIRHOLM	MOUNT HAWK		Nisku (D2)
	PERDRIX (FIDDLE)	WOODBEND FORMATION	Ireton (green shale)
			Leduc (D3)
			Duvernay
	FLUME		Cooking Lake
		BEAVERHILL LAKE FORMATION	

The Graminia, Calmar, and the Cooking Lake members, and the Beaverhill Lake formation are not clearly defined in the areas concerned. According to * Warren (1955), the Fiddle

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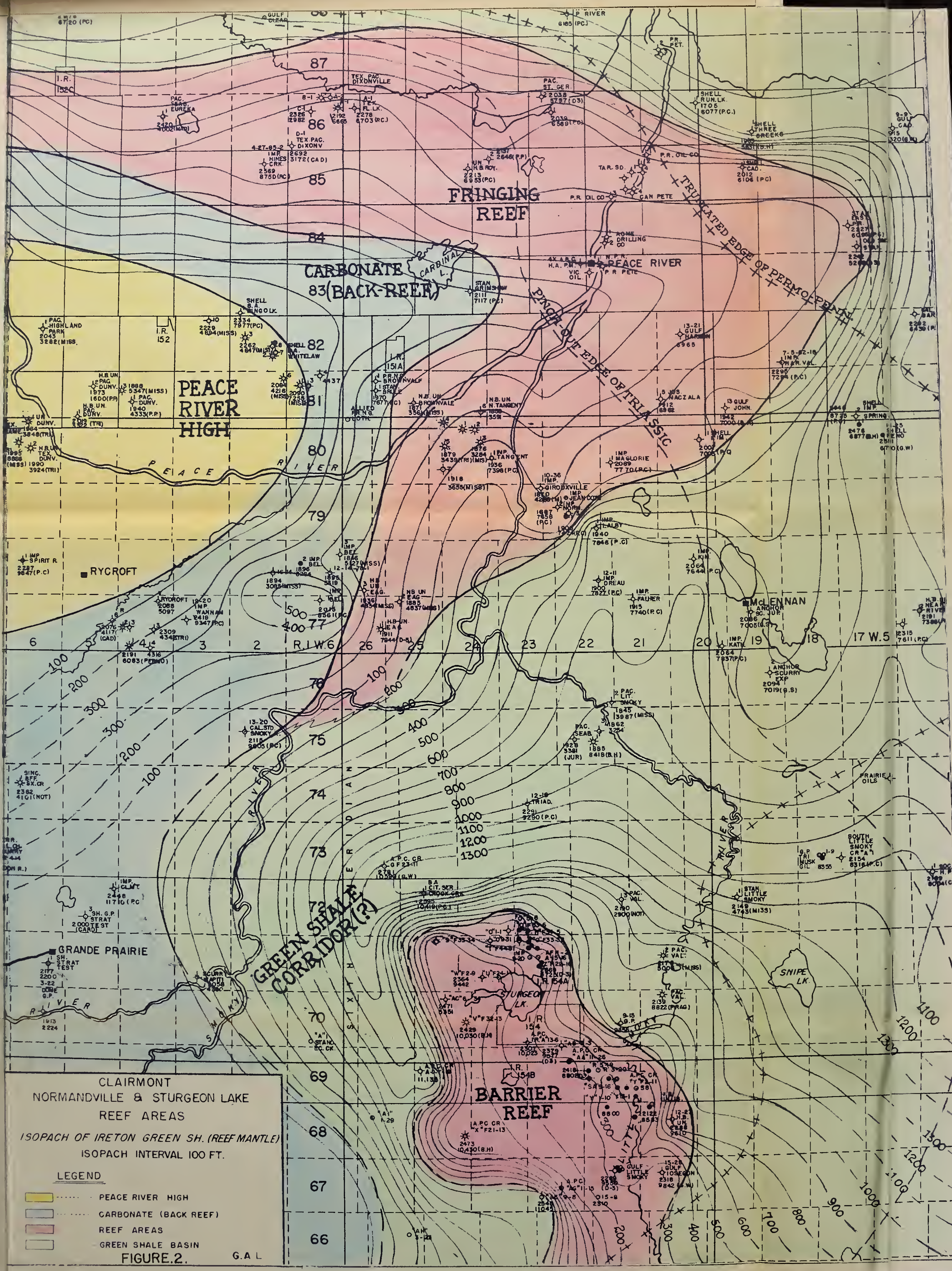
* Personal communication.



CLAIRMONT
NORMANDVILLE & STURGEON LAKE
REEF AREAS

ISOPACH OF IRETON GREEN SH. (REEF MANTLE)
ISOPACH INTERVAL 100 FT.

LEGEND

- 🟨 PEACE RIVER HIGH
- 🟦 CARBONATE (BACK REEF)
- 🟥 REEF AREAS
- ☐ GREEN SHALE BASIN

FIGURE.2. G.A.L.

to be fragmental and oolitic in part. It has a general thickness of 750 feet in the Sturgeon Lake area and thickens to 900 feet in the Clairmont and Normandville areas.

The Upper Devonian formations are truncated in a general north-south trend to the east of the Ireton isopach map area. The pinch-out line of the Triassic and truncated edge of the Permo-Penn. are shown in the map area.

General Tectonics

As discussed by Webb (1954) and Goodman (1954), the tectonic units which influenced Upper Devonian reefing in Northwestern Alberta were the positive Pre-Cambrian high land, referred to as the Peace River high, which dips rapidly in partially defined directions into the Woodbend (Ireton) green shale basin. The Peace River high was known to influence basinal configurations through such features as faulting, warping and tilting, and to have been the source area for a series of re-worked Pre-Cambrian sediments called "granite wash" which blankets the basin and ranges in thickness up to 300 feet in its deeper regions. The Peace River high was inundated in Upper Devonian (Wabamun) time by the rising of the sea level and by its gentle subsidence and tilting into the Cordilleran geosyncline. The basin shallowed gradually to the east onto an expansive bench which trended northwest - southeast.

In Woodbend time favorable conditions for reef development existed in the fringing shallow water platform areas around the Peace River high, as evidenced by the Normandville complex in particular, and by other Devonian sections studied in the marginal areas of the high. The Sturgeon Lake complex, however, is considered by the author to have developed on a gently subsiding platform under shallow water conditions in the basin proper and to have been primarily influenced by more regional tectonic elements than the Peace River high.

Nomenclature

The names Normandville, Clairmont and Sturgeon Lake reefs have been used to define the Upper Devonian reefoid member as it is found in the respective areas. The names were devised by the oil companies concerned to necessarily distinguish these reef masses. Although tentative correlations are made between these sections and also with Upper Devonian reefs in the central plains area, no sound basis has been found to date to definitely establish either a local or regional correlation. The use of specific names, therefore, is warranted.

Exploration companies in the area have used the Upper Devonian nomenclature as initiated by Imperial Oil Limited in the central plains area and the Leduc oil field in particular. The use of this nomenclature in Northwestern Alberta has led to criticism of its reliability by some factions. Although some Winterburn members are missing in

Northwestern Alberta, the nomenclature has proved satisfactory regardless of the possible error assumed by a similar use of an alien nomenclature from an uncorrelated area.

Location of the Sturgeon Lake, Normandville and Clairmont Reefing Areas

The areas are located within the bounds of Townships 68 to 79, inclusive, and Range 21 West of the 5th Meridian to Range 5 West of the 6th Meridian, in the general region of Northwestern Alberta. The names of the areas, as used, refer to their specific locales. (See Figure 2, following p. 10.)

Well locations from which samples were studied are as follows:

Well Name	Location
Imperial Clairmont No. 1	16 - 25 - 72 - 5 W6
Amerada Crown "AD" 7-19	7 - 19 - 69 - 25 W5
Amerada Crown "V" F32-13	10 - 13 - 70 - 25 W5
Amerada Indian Reserve "A" 13-6	13 - 6 - 70 - 23 W5
Amerada et al Crown "Y" 2-11	2 - 11 - 69 - 22 W5
Amerada Crown "O" F33-32	7 - 32 - 71 - 23 W5
Imperial Normandville No. 2	10 - 20 - 79 - 22 W5

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CHAPTER 3

CHEMICAL ANALYSIS

General Statement

Conventional quantitative methods of chemical analysis have been used by numerous investigators in the study of limestones, dolomites and insoluble residues. Investigations of particular note were made by Judd (1904), Steidtmann (1911), and Tarr (1919) in their studies of dolomitic leaching and the period of dolomitization; and by Griffin (1942) and Thiel (1946), in work on the physical properties and petrographic characteristics of limestones and dolomites.

In the past, time consuming techniques retarded the use of quantitative analysis in the study of sediments and consequently more functional, yet accurate, methods of analysis have been sought. A chelating agent known as disodium versenate (versene) which was prepared by Ender, as cited by Bersworth (1951), was used by Cheng, Kurtz and Bray (1952), for the quantitative determinations of calcium, magnesium and iron in sediments. More recently, Chilingar (1953) used the versenate method in the analysis of 3000 limestone and dolomite samples and reported favorable agreement of this method with standard wet techniques.

Upon reviewing the satisfactory results previously obtained in the use of the versenate method for limestone, dolomite and iron determinations it was adapted to the investigations undertaken by the author.

Standardization of Versene (Disodium Versenate)

A standard solution of suitable molarity for the following determinations was made up by the solution of approximately 10 grams of disodium versenate in 1 litre of distilled water. The solution was standardized in quantities of 16 litres.

The molarity of the solution was established by standardization against calcium carbonate which was 99.3 + or - 0.4 percent pure. Three separate quantities of 0.1000 grams of chemically pure calcium carbonate was weighed (+ or - 0.0005 grams) and dissolved in 10 millilitres of concentrated hydrochloric acid, to be used as standard controls. To each control was added 0.001 grams of magnesium as a measured dilute solution of magnesium chloride. Five millilitres of *buffer solution (consisting of 67 grams of ammonium chloride dissolved in 570 millilitres of ammonium hydroxide and diluted to 1 litre) were added to each control along with eriochrome black T. indicator. The controls were titrated with versene until a medium, clear blue end point was reached. The volume in millilitres of versene used in reaching the end point was designated as (V_1) for calculation purposes.

To three separate measured volumes of **magnesium chloride (which contained 0.001 grams of magnesium) was added ammonium chloride - ammonium hydroxide buffer and indicator

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* Buffer was added to adjust the p.h. within the range of 8 to 9, whereas the direct use of ammonium hydroxide tended to make the p.h. too high.

** Forms a red complex in the presence of eriochrome black T.

as above, and similarly titrated with versene until a medium, clear blue end point was reached. The volume in millilitres of versene used in reaching the end point was designated as (V_2) for calculation purposes.

The molarity of the versene was calculated as follows:

$$M\ (\text{versene}) = \frac{1000}{V_1 - V_2} \times \frac{\text{weight of } CaCO_3 \text{ used in control}}{\text{molecular weight of } CaCO_3}$$

Example:

$$M\ (\text{versene}) = \frac{1000}{37.25 - 1.29} \times \frac{0.1000}{100.08} = .02776N.$$

Checks were made on the molarity of the versene every 10 days and variations in the third decimal of the molarity were considered significant.

Sampling for Quantitative Chemical Analysis

The two types of material for analysis were drill cuttings and cores and the sampling technique varied accordingly. In the wells where cores were taken, cuttings samples were dispensed with at the wellsite. Coring provided the better samples because the material was free from any contamination due to up-hole cavings and recirculated cuttings. Selection of samples from the cores was more accurate since lithological changes could be readily observed and, in addition, errors in correlating samples with depth were reduced to a minimum. Samples from the cores were taken every 5 feet for dolomite, limestone, anhydrite and pyrite determinations

and strategically sampled through lithological differences for additional determinations. An accumulative gross sample which varied from 150 to 200 grams was taken representing a core fraction of generally homogeneous lithology. The gross sample was thoroughly mixed and crushed in a mortar to a desirable size of 1/2 centimeter in diameter or less, for weighing and dissolution in hydrochloric acid. More active solution of the material was obtained in the smaller fragment sizes because of greater areal exposure to the action of the acid. The cuttings samples, which must be considered as accumulative samples taken every 5 feet at the wellsite, were integrated every 10 feet and sampled for analysis.

Following the crushing and mixing of the gross sample, it was dried for no less than 12 hours under controlled temperatures of 90 to 98 degrees centigrade and, upon cooling, a 20 gram aliquot of the gross was weighed to an accuracy of + or - 0.001 grams. In order to facilitate rapid weighing of the samples a shallow, elongated, hexagonal aluminum tray was shaped in the dimensions of 6.5 centimeters long, 3.5 centimeters wide and 0.2 centimeters in thickness, which was abraised and polished until it counterbalanced a 1 gram weight to + or - 0.001 grams. The tray of the above dimensions was found to contain 20 grams of material in the density range of 2.5 to 3.0 for weighing purposes. A marked expediency was found in the weighing of the samples by use of the counterbalanced tray.

It was considered practical to process at least

20 samples for each phase of analysis since certain steps were time consuming (i.e. filtration) which resulted in inefficiency if a lessor number of samples were processed. As the routine became more familiar, it was possible to increase the number of samples per phase of analysis to 30.

Solution of Samples for Quantitative Analysis

The 20 gram sample of material was brushed from the weighing tray into a 300 cubic centimeter erlenmeyer and sufficient chemically pure concentrated hydrochloric acid was added to bring about solution of the material. Macroscopically, the material was found to consist mainly of dolomite which, from calculations, would require approximately 40 millilitres of concentrated hydrochloric acid to dissolve 20 grams of sample. It was found, however, that an additional 10 to 12 millilitres of acid was necessary for complete digestion of the material.

Effervescence was observed immediately upon the addition of the concentrated hydrochloric acid and was observed to vary in intensity as a direct function of the percent limestone. In order to reduce the rate of reaction of the concentrated acid on the insoluble residue, 100 millilitres of distilled water were added. To complete the solution of the dolomite it was required to bring the samples to a gentle boil for at least 20 minutes or until clastic fragments of dolomite were no longer present in the solution.

After solution of the material was complete the

samples were cooled and diluted to 1 litre. (It was found in this phase that any anhydrite which had resisted solution in the concentrated acid would go into solution. In some instances, where the anhydrite content was excessive, agitation was required to assist in the dissolution of the anhydrite.) The diluted sample was filtered to remove the insoluble residue which was washed with distilled water and preserved for ignition and weighing. (See Determination of Insoluble Residue.)

Determination of Limestone ($CaCO_3$) and Dolomite ($CaCO_3.MgCO_3$

For limestone determinations a 5 millilitre aliquot part was taken of each sample and diluted to 25 millilitres. Five millilitres of ammonium hydroxide - ammonium chloride buffer was added and, in addition, 0.02 grams of hydroxylamine hydrochloride ($NH_2OH.HCL$) and 0.2 grams of potassium cyanide (KCN) were added to remove traces of transition metals present which would interfere with the reading of the end point of titration. Four or five drops of eriochrome black T. indicator was added and each sample was titrated with versene until the titrated solution changed from a red-violet to a clear, medium blue color (end point is quite sharp). The volume in millilitres of versene used in reaching the end point was designated as V_{Ca} for calculation purposes.

For each sample a 10 millilitre aliquot part of the 1 litre solution was taken and diluted to 25 millilitres

and 0.3 grams of ammonium* oxalate $(NH_4)_2 C_2O_4.H_2O)$ was added to the diluted aliquot, followed by 3 drops of methyl red; (excessive methyl red tended to obliterate the blue color of the end point).

The diluted aliquot was neutralized slowly with concentrated ammonium hydroxide (NH_4OH) until the solution was slightly basic. The solution was allowed to stand at least 10 minutes to enable the precipitation of calcium oxalate (CaC_2O_4) to reach completion. The precipitate was filtered from solution and was washed 3 times with a dilute solution of ammonium oxalate and ammonium hydroxide (0.1 grams of $(NH_4)_2C_2O_4.H_2O$ plus 10 millilitres of ammonium hydroxide diluted in 300 millilitres of distilled water). The washings were allowed to accumulate in the filtrate.

To the filtrate was added 0.02 grams of hydroxylamine hydrochloride and 0.02 grams of potassium cyanide, and the p.h. was adjusted within the range of 8 to 9 by the addition of 2.5 millilitres of concentrated ammonium hydroxide. Eight to 10 drops of eriochrome black T. indicator was added and the filtrate was titrated with versene until a clear, medium blue end point was reached. (The end point tended to be slightly green, particularly if an excess amount of methyl red had been added previously.) The volume in millilitres of versene used in reaching the end point was designated

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* The calcium ion was removed for the determination of the magnesium ion in the form of a precipitate of calcium oxalate which was discarded.

as (V_{Mg}) for calculation purposes.

Calculations:

$$\frac{\text{Percent}}{\text{Limestone}} = \frac{(V_{Ca} - V_{Mg})}{1000} \times \frac{M(\text{versene}) \times \text{mol. wt. } CaCO_3 \times 100}{\text{weight of aliquot}}$$

To simplify the use of the above formula a constant was derived which was a direct function of the molarity (M) of the versene.

Example: the original molarity of the versene used for determination was 0.02776.

$$\frac{\text{Percent}}{\text{Limestone}} = \frac{(V_{Ca} - V_{Mg})}{1000} \times \frac{0.02776 \times 100.08 \times 100}{0.100} = 2.78 \times (V_{Ca} - V_{Mg})$$

Therefore, the constant = 2.78

$$\frac{\text{Percent}}{\text{Dolomite}} = \frac{V_{Mg}}{1000} \times \frac{M(\text{versene}) \times \text{mol.wt. } CaCO_3.MgCO_3 \times 100}{\text{weight of aliquot}}$$

Similarly, as above, a constant was derived which was also a direct function of the molarity (M) of the versene.

Example: the original molarity of the versene used for determination was 0.02776.

$$\frac{\text{Percent}}{\text{Dolomite}} = \frac{V_{Mg}}{1000} \times \frac{0.02776 \times 184.40 \times 100}{0.200} = 2.56 \times V_{Mg}$$

Therefore, the constant = 2.56

It was necessary to recalculate the constants whenever a change in the third decimal was found in the molarity of the versene.

Determination of Anhydrite ($CaSO_4$)

For each determination, a 250 millilitre aliquot part of the dissolved sample was taken and its p.h. was lowered in the range of 1 or less by the addition of 2 millilitres of concentrated hydrochloric acid. Any transition metals present were removed by the addition of hydroxylamine hydrochloride and potassium cyanide. The solution was brought to a gentle boil and a 10 percent solution of barium chloride was added slowly and with continual agitation. The solution was then permitted to cool for at least 1 hour to enable the precipitation of barium sulphate to reach completion.

Following complete precipitation the precipitate was filtered using #40 quantitative paper and washed 3 times with hot distilled water. The precipitate was ignited for a minimum of 30 minutes over an oxidizing bunsen flame in covered porcelain crucibles which were previously weighed (+ or - .001 grams). Upon cooling, the precipitate and crucible were weighed and the weight of precipitate determined.

Calculations:

$$\text{Percent Anhydrite} = \frac{\text{weight of ppt.}}{\text{weight of aliquot}} \times \frac{\text{mol.wt. } CaSO_4}{\text{mol.wt. } BaSO_4} \times 100$$

A constant weight of aliquot was used (250 millilitres = 5 grams) and it was possible to derive a constant for more rapid calculations.

Example:

$$\frac{\text{Percent}}{\text{Anhydrite}} = \frac{\text{weight of ppt.}}{5.000} \times \frac{136}{233.3} \times 100 = 11.66 \times \text{weight of ppt.}$$

Therefore, the constant = 11.66

Determination of Pyrite (FeS_2)

For each determination a 5 gram sample was weighed (+ or - 0.001 grams) from the original dried sample and dissolved in a minimum of concentrated nitric acid (approximately 10 to 12 millilitres). Thymol blue indicator was added (which undergoes a color change over an extremely low p.h. range of from 2 to 3; when the p.h. is less than 1.2 to 2.8 the thymol blue color indicator is red, and at a p.h. greater than 2.8 the indicator becomes yellow). When necessary, additional concentrated nitric acid was added in order to adjust the p.h. in the approximate range of from 2 to 3. Final adjustment in p.h. was made by the addition of an appropriate volume of 15 percent sodium acetate,(a yellow-orange coloration signifies the correct p.h.).* Ten millilitres of 2 percent **salicyclic acid was added slowly to the solution which reacted with the iron in solution to form a red complex. The solution was titrated with versene until a distinctly yellow end point was reached. The volume in millilitres of versene used in reaching the end point was designated as V_{Fe} for calculation purposes.

* Only 1 millilitre was required for the volume of sample used. The excess, which was added in error, did not seem affect the results.

** Salicyclic acid reacts with the iron to form a red complex which is not as stable as a disodium versenate - iron complex. The iron which is bonded in the salicyclic acid complex reacts with the versene to form a more stable complex upon titration.

Calculations:

$$\frac{\text{Percent}}{\text{Pyrite}} = \frac{V_{Fe}}{\quad} \times \frac{\text{M(versene)} \times \text{mol. wt. } FeS_2 \times 100}{\text{weight of sample}}$$

To simplify the use of the above formula a constant was derived.

Example: the original molarity of the versene used for determination of pyrite was 0.02671.

$$\frac{\text{Percent}}{\text{Pyrite}} = \frac{V_{Fe}}{1000} \times \frac{0.02671 \times 119.8 \times 100}{5.000} = 0.641 \times V_{Fe}$$

Therefore, the constant = 0.641

Determination of Insoluble Residue

The insoluble residue from each sample, which had been filtered off the diluted 1 litre sample, (see Solution of Samples) was examined microscopically to determine its general constituents, which were found to consist predominantly of silt, clay and pyrite with minor amounts of quartz and bitumen present. Considering the small amounts of residue remaining it was impractical to attempt its removal from the filter paper and consequently, in view of the stable constituents present (except pyrite), a weight determination by ignition was undertaken. A conversion factor was used to determine, from the calculated weight of pyrite present, the weight of iron oxide (oxidized pyrite during ignition) in the ignited sample. The bitumen, although altered, was not entirely oxidized by the temperatures used in ignition. In any event, the bitumen was a minor constituent which would inappreciably effect the calculations of the percent insoluble residue in the material.

The insoluble residue which was contained in #40 quantitative paper was ignited for a minimum of 30 minutes over an oxidizing bunsen flame in a covered porcelain crucible which was previously weighed (+ or - 0.001 grams). Upon cooling, the precipitate and crucible were weighed and the weight of insoluble residue determined.

Calculations:

From the percent pyrite in the sample, which had been previously determined (see Chemical Composition - Appendix A; p.p. 46 - 50), the weight of pyrite present in the original 20 gram sample was calculated. This gram weight of pyrite was multiplied by a conversion factor of $\frac{Fe_2O_3}{2(FeS_2)} = \frac{159.6}{239.6} = \underline{.667}$ to determine the weight of iron oxide (Fe_2O_3) contained in the insoluble residue. By subtracting the weight of iron oxide from the weight of insoluble residue, the weight of constituents other than pyrite was calculated. The weight of pyrite was included with the weight of the other constituents in graphing and tabulating the percent of insoluble residue; (see Tabulated Results - Appendix A; p.p. 46 - 59).

Determination of Calcium - Magnesium Ratios ($^{Ca}/_{Mg}$)

In the determination of $^{Ca}/Mg$ ratios, calcium was considered to be present in the samples as dolomite ($CaCO_3 \cdot MgCO_3$), anhydrite ($CaSO_4$) and limestone ($CaCO_3$) and the magnesium solely as dolomite, (see Discussion of Possible Errors).

The $^{Ca}/_{Mg}$ ratio for each sample was calculated as follows:

$$* \quad C_{Ca} = \frac{\text{mol. wt. Ca}}{\text{mol. wt. } CaCO_3} \text{ X } \% \ CaCO_3 + \frac{\text{Mol. wt. Ca}}{\text{mol. wt. } CaCO_3.MgCO_3} \text{ X } \% \ CaCO_3.MgCO_3 + \frac{\text{mol. wt. Ca}}{\text{mol. wt. } CaSO_4} \text{ X } \% \ CaSO_4$$

$$** \quad C_{Mg} = \frac{\text{mol. wt. Mg}}{\text{mol. wt. } CaCO_3.MgCO_3} \text{ X } \% \ CaCO_3.MgCO_3$$

Therefore, $^{Ca}/_{Mg}$ ratio $= {}^{C_{Ca}}/_{C_{Mg}}$

Discussion of Assumptions, Limitations and Possible Errors

Since a large number of samples were to be analyzed, time consuming procedures such as the use of fourth place decimal accuracies in sample weighing were dispensed with. Constant procedures were used to restrict errors to a minimum. First place decimal accuracies in the calculation of constituent percentages were possible which was considered satisfactory for comparative purposes.

For practical purposes, it was necessary to make certain assumptions regarding the mineral components present in the material. It was assumed that magnesium was present only as dolomite ($CaCO_3.MgCO_3$) and that such magnesium minerals as magnesite ($MgCO_3$), brucite ($Mg(OH)_2$) or kieserite ($MgSO_4.H_2O$) et al, were present in insignificant amounts (none were identified in thin section). Calcium was regarded as

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* C_{Ca} = percent of calcium in the sediment.

** C_{Mg} = percent of magnesium in the sediment.

being present as limestone ($CaCO_3$), anhydrite ($CaSO_4$) and dolomite ($CaCO_3.MgCO_3$). The iron components were considered to be products of a reducing environment and therefore formulated as pyrite (FeS_2). Traces of ankerite (iron rich dolomite) were observed in some instances, however, the concentration was considered to be insignificant.

In the quantitative determination of pyrite (FeS_2) an indeterminable amount was probably dissolved in the concentrated hydrochloric acid. It was not possible, by the methods used, to account for the loss of iron as a result of the solubility of pyrite in the acid. The error thereby incurred was considered to be slight and did not appear to invalidate the use of the results.

In order to establish the consistency of the end points of titration and to substantiate the accuracy assumed from calculations, 2 or 3 controls were run on each of the first 12 samples. It was found that the accuracy attained was within the calculated limits and only one determination per sample was subsequently necessary. Whenever an additional 16 litres of versene were standardized a number of the samples titrated with the new reagent were duplicated until the results were found to be within the calculated limits of accuracy.

Although the ignition method used in the determination of the percent insoluble residue constituted obvious errors in the alteration and oxidation of the constituents, a more satisfactory method was not apparent, considering the

minute volumes of residue concerned. Pyrite was one of the major constituents of the residues and by the application of a conversion factor to correct for its alteration upon ignition, it was possible to calculate its percentage of the residue in its original sulphide form.

The error in the accumulative totals of the results was calculated to be + or - 0.5 percent.

Presentation of Results

The results are tabulated in Appendix A, p.p. 46 - 59. The graphic results are compared with the diagenetic features which are presented in stratigraphic sequence in pocket insert 1.A. A stratigraphic cross-section comparing detailed features of the reef complexes is presented in pocket insert 1.B.

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CHAPTER 4

FOSSILS AND FOSSIL REMNANTS FROM THE STURGEON LAKE NORMANDVILLE AND CLAIRMONT REEF COMPLEXES

General Statement

Previous work done in the areas has generally concluded that the Normandville and Clairmont sediments are definitely reefal. However, the lack of organic evidence in the Sturgeon Lake complex has resulted in two fields of thought:

(a) The Sturgeon Lake complex represents a dolomitized limestone facies change in the Woodbend (Ireton) green shale and is not reefal by definition.

(b) Although no distinctive fossil evidence has been discovered, the Sturgeon Lake complex is definitely reefal because its outlying position in the more stable regions of the green shale basin is not congruent with such a drastic and abrupt lithological change. In addition, differential compaction of the Ireton green shale mantle has resulted in an anomalous draping over the complex which is a typical condition associated with a number of other Alberta Devonian reefs.

An effort was put forth by the author to discover sufficient fossil evidence in the Sturgeon Lake complex to establish its organic origin. The investigation of possible

fossil remnants in the complex was attempted through the medium of polished and thin sections. In anticipation of sufficient fossil evidence to form a basis for correlation, similar polished and thin sections were prepared from cores of the Normandville and Clairmont sediments.

Selection of Petrographic Specimens

Cores from Amerada Crown "O" F33-32, Amerada et al Crown "Y" 2-11, Imperial Normandville No. 2, and Imperial Clairmont No. 1, were examined with the aid of a binocular microscope in search of fossil remnants or indicative structures. The limestone and shale facies were given particular attention as it was assumed that fossil structures would be best preserved in these phases. Material revealing shadow patterns, symmetrical forms or other apparent remnant fossil structures was prepared for polished and thin section study.

Preparation of Petrographic Sections

Thin sections were prepared in the usual manner.

Polished sections were sized and mounted as in the preparation of the thin sections. The sections were then polished with Nos. 200 and 400 abrasive powders on the sides for examination under direct and reflected light. Since a suitable staining technique was to be employed to enhance the contrast of shadowed and other remnant fossil forms, a finer polish was not desirable. It was found that a finer polish on the surfaces to be stained inhibited their absorbent qualities.

Staining Technique

Examination of the original core specimens and the polished sections in direct light resulted in unsatisfactory identification of apparent fossil structures. It was concluded that, by the use of a staining technique, better contrast could be attained between the dolomite ground mass and the altered, fossil remnants.

In an effort to find a suitable stain the Heegar potassium ferricyanide and copper nitrate methods were tried as outlined by L.W. Le Roy (1950). However, the Otto potassium chromate method, as recommended by Krumbein and Pettijohn (1938), was found to provide the most satisfactory results.

The Otto potassium chromate method employs a 10 percent solution of silver nitrate in which the polished or thin section is treated from 2 to 5 minutes and subsequently washed with distilled water to remove all traces of the nitrate solution. The section is then suspended in a neutral solution of 5 percent potassium chromate for 3 minutes and washed again in distilled water and dried. Calcite and limestone was observed to assume a red-brown stain while dolomite retained its original color. The time of submersion in the silver nitrate was limited to 1 minute which produced a milder stain in the calcite and limestone fractions. A more intensive staining had the adverse effect of over shadowing and obliterating the remnant fossil structures.

For examination of the stained polished sections, the most favorable results were obtained by the use of a

reflection microscope. The sections were dampened with water which, upon reaching a certain stage of evaporation, increased the degree of light penetration, thereby unveiling the remnant fossil structures. The fossil remnants which were observed in reflected light were sketched for photographic reproduction. (See Appendix B, p.p. 61 - 66.)

A study of the thin sections for fossil remnants produced negative results. They were preserved along with the polished sections for micropetrographic studies.

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CHAPTER 5

MICROPETROGRAPHIC STUDY OF POLISHED AND THIN SECTIONS OF THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT REEF COMPLEXES

General Statement

To determine the history of a sediment a study must include, in addition to chemical composition and determinations of insoluble residue constituents, such morphological criteria as textural relationships between individual components, inclusions (authigenic or allogenic), color, overgrowths and structures. Such authors as Howell (1922) and Goldrich and Parmelee (1947) made use of these features in their diagenetic studies of dolomites and limestones from polished and thin sections. In view of the diagnostic results they obtained, these features were investigated in polished and thin sections of the reef complexes. The sections were prepared previously; (see Preparation of Petrographic Sections p. 30).

An improved classification and precision of nomenclature was devised by the application of quantitative values to the textural studies of the complexes.

In studying the crystal features and facies changes of the sediments the Wentworth grade scale, as cited by Twenhofel (1926), was modified by the author as a dimension of crystal size.

Wentworth Grade Scale:

Very coarse grain (crystalline)	1.0 - 2.0 m.m.
Coarse grain (crystalline)	1.0 - 0.5 m.m.
Medium grain (crystalline)	0.5 - 0.25 m.m.
Fine grain (crystalline)	0.25 - 0.125 m.m.
Very fine grain (crystalline)	0.125 - 0.067 m.m.
Cryptocrystalline	less than 0.067 m.m.

Degrees of crystallinity and crystal form, as defined by Tyrrell (1949) in his description of textures in igneous rocks, were adapted by the author for use in the microscopic description of textures.

Degrees of Crystallinity - Tyrrell

Holocrystalline	texture composed entirely of crystalline material.
Merocrystalline	texture composed partly of crystalline material.
Holohyaline	texture composed entirely of non-crystalline material.

Crystal Form - Tyrrell

Euhedral	crystal entirely bounded by faces.
Subhedral	crystal partly bounded by faces.
Anhedral	absence of crystal faces.

A tabulated chart and graphic representation in stratigraphic sequence was made of the textural and structural features. This method of presentation was regarded as most practical for purposes of comparison. (See pocket insert 1.A.)

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CHAPTER 6

CONCLUSIONS

Physical and chemical investigations conducted on the Sturgeon Lake, Normandville and Clairmont reef complexes brought to view certain conclusions regarding their diagenetic and tectonic history. The details of investigation are shown in tabulated and graphic form (pocket insert 1.A.) and in detailed cross section (pocket insert 1.B.).

The results are integrated or discussed separately in order to emphasize certain implications.

Chemical Composition

Quantitative chemical analysis proved to be ineffectual as far as the correlation of stratigraphic units is concerned. The quantitative results served their most useful purpose in clearly defining facies changes.

As shown by the work of Chilingar (1953), similar and constant $^{Ca}/_{Mg}$ ratios indicate a similar age of deposition in a regionally stable platform area. Generally similar and constant $^{Ca}/_{Mg}$ ratios were recorded in the Sturgeon Lake and Normandville sediments in particular. His work also showed that chemically precipitated sediments have a much higher $^{Ca}/_{Mg}$ ratio than do those of organic origin. He was able to conclude that sediments having lower $^{Ca}/_{Mg}$ ratios than 3.35:1 must derive a considerable portion of their magnesium from organic sources. In applying this

interpretation of $^{Ca}/_{Mg}$ ratios to the results obtained by the author, an intense and persistent organic origin is suggested in all three complexes; particularly in the Sturgeon Lake reef.

It was observed that the extent of dolomitization and crystal size is an inverse function of the $^{Ca}/_{Mg}$ ratio. With reference to the tabulated data, the Sturgeon Lake complex shows a particularly constant and advanced stage of dolomitization while the Normandville and Clairmont sediments tend to vary.

Pyrite was present throughout the dolomite complexes in both disseminated and concretionary forms and as a replacement mineral in fossil structures. Significant variations in pyrite concentrations served to indicate certain horizons of more intense putrefraction in a strongly reducing environment. As cited by Pettijohn (1948), Ruby noted the relationahip between pyrite, organic matter and carbonates in certain Cretaceous horizons and concluded that the most favorable conditions for the formation and preservation of these components together was a typical shallow water environment with the rapid accumulation and burial of organic debris (i.e. a reef building environment). These features are worthy of note in that they supplement evidence to be discussed favoring reef development, rather than facies changes, in the sedimentary history of the Sturgeon Lake complex.

Insoluble Residues

The primary purpose in an investigation of the insoluble residues was to conduct a comparative and correlative study of the heavy mineral fractions. The heavy mineral components were found to be insufficient and insignificant for consequental study. Infrequent, fine, anhedral crystals of garnet, tourmaline and zircon were identified in the residues.

Higher concentrations and coarser textures in the Normandville and Clairmont residues did serve to indicate nearer shore conditions during deposition than those from Sturgeon Lake. (See pocket insert 1.A. - Insoluble Residues.)

Fossil Remnants and Further Evidence of Organic Reef Development

Altered and replaced colonial forms of Coelenterata, Crinoidea, Bryozoa and occasional algal remnants were identified from the polished and thin sections. The photographed sketches of these organisms are included in Appendix B, p.p. 61 - 66.

Although the diagnostic features of these organisms were inadequately preserved for correlation purposes, their identification in the Normandville and Sturgeon Lake sections further substantiates the belief that both complexes are reefal. Suggestion of a suitable shallow water reef building environment is offered by the identification of calcareous algal remnants in both sections. Additional evidence of shallow water conditions is suggested by the intermediate or

post reefal evaporitic and pyritic sequences. A final concluding fact that the Sturgeon Lake complex in particular, is truly a biohermal reef and not a facies change in the Ireton green shale is presented in Twenhofel's (1950) reef definition in which he stated that his observations have shown a more vertically inclined development to be possible for reefs than for most sedimentary materials. The precipitous conditions on the Sturgeon Lake reef margins further signifies, therefore, a true biohermal reef development.

Microscopic Textures and Structures

These features are detailed in a graphic and tabulated form in pocket insert 1.A. Photographs of representative textures are shown in Appendix C, p.p. 67-77.

Following is a brief comparative discussion of the diagenetic processes and their effects on the Sturgeon Lake, Normandville and Clairmont sediments as disclosed from their textural properties in particular.

The process of compaction acting on the Sturgeon Lake and Normandville sediments is not apparent in their textures and appears to have been negligible. Their porosity and permeability are more directly attributed to leaching rather than the effects of compaction. The differential compaction and draping of the Ireton green shale mantle over these reef masses further indicates their resistance to compaction. The Clairmont dolomites, however, do show the effects of compaction processes in their lack of effective permeability and porosity and in their rude bedding and

partial lineation of allogenic debris. Bedded structures were notably absent in the Sturgeon Lake and Normandville sediments.

Metasomatic dolomitization and recrystallization is apparent in all three dolomitic sequences as evidenced by the coarse, euhedral, holocrystalline textures which are particularly dominant in the Sturgeon Lake dolomites. Allogenic and authigenic inclusions and crystal overgrowths in the Sturgeon Lake and Normandville dolomites are notable also as features of recrystallization.

Textural studies of all three complexes show that cementation and interstitial mineralization occurred both contemporaneously and after dolomitization. Although some of the cementation materials appear to have been derived authigenically, the predominant mass of interstitial clay, fine silt and quartz is allogenic. These interstitial constituents were coarser, darker, more prominant and more diffused in the Normandville and Clairmont dolomites, while the Sturgeon Lake dolomites displayed a finer, more incipient matrix of a lighter color.

The cementation products in the Clairmont sediments are unique in that variations in their concentrations and color emphasized the rude bedding structures.

Although differential solution processes were no doubt important agencies during the dolomitization of all three complexes, their effects were rarely observed in the

coarse, holocrystalline texture of the Sturgeon Lake sediments. Differential solution effects were obvious as textural variances in crystal size, shape, color and composition in the Clairmont and Normandville dolomites throughout stages of incomplete dolomitization or in minor facies changes. In some instances a mottled appearance was observed in the Normandville dolomites as a result of variable textures, and varying concentrations of disseminated iron and silt. Evidence of this phenomenon appeared to vary inversely as the extent of recrystallization.

Authigenic processes are particularly evident in the formation of the dolomites proper and in the replacement mineralization in fossil structures and vugs, which consists of pyrite, calcite and anhydrite. Rare authigenic feldspar aggregates associated with fine gray silt and clay were identified in the Clairmont sediments. The fine size and anhedral shape of the quartz and heavy mineral grains designates them as allogenic products of transposition.

In summation, quantitative investigations have shown a very similar diagenetic history and environment in the development of the Sturgeon Lake and Normandville reef complexes. By integrating their diagenetic elements with broader features in the area a better conception is realized of the basinal orientation of the reefs and their tectonic history; (see isopach map of the Ireton following p. 10). It is apparent that reefs developed at Sturgeon Lake and Normandville on gently subsiding platforms in

clear, shallow basinal environments. The Sturgeon Lake complex, which is remarkably thick, massive and homogeneous lithologically, is indicative of stable conditions during deposition, in contrast to the less stable conditions indicated by cyclic phases of deposition in the Normandville complex.

With further reference to the Ireton isopach map, the diagenetic features of the Clairmont and western off reef Sturgeon Lake sediments suggest a stable shelf or restricted back reef depositional environment. Suggestion is made also of a broad shelf extending from the Clairmont area south and beyond the western flank of the Sturgeon Lake reef by the sparseness or absence of marine sequences older than Upper Devonian along the outer eastern margin of the Rocky Mountain disturbed belt.

A restricted and shallowing green shale corridor separating the western margin of the Sturgeon Lake reef from the possible shelf area to the west is indicated by a study of the diagenetic features of the sediments pertinent to the area and from an examination of cuttings samples and electrologs of the Upper Devonian from more regional wells.

Reef development appears to have been abruptly terminated by a major diastrophic event which was followed by undulating platform conditions. A slight pivoting about the Peace River high and moderate tilting into the Cordilleran geosyncline was the final tectonic stage in orientation of the reefs.

A stratigraphic cross section of the Upper Devonian is illustrated in Figure 3, following p. 42, which shows the tectonic elements and their effects of basinal configuration upon the stratigraphy of the areas concerned.

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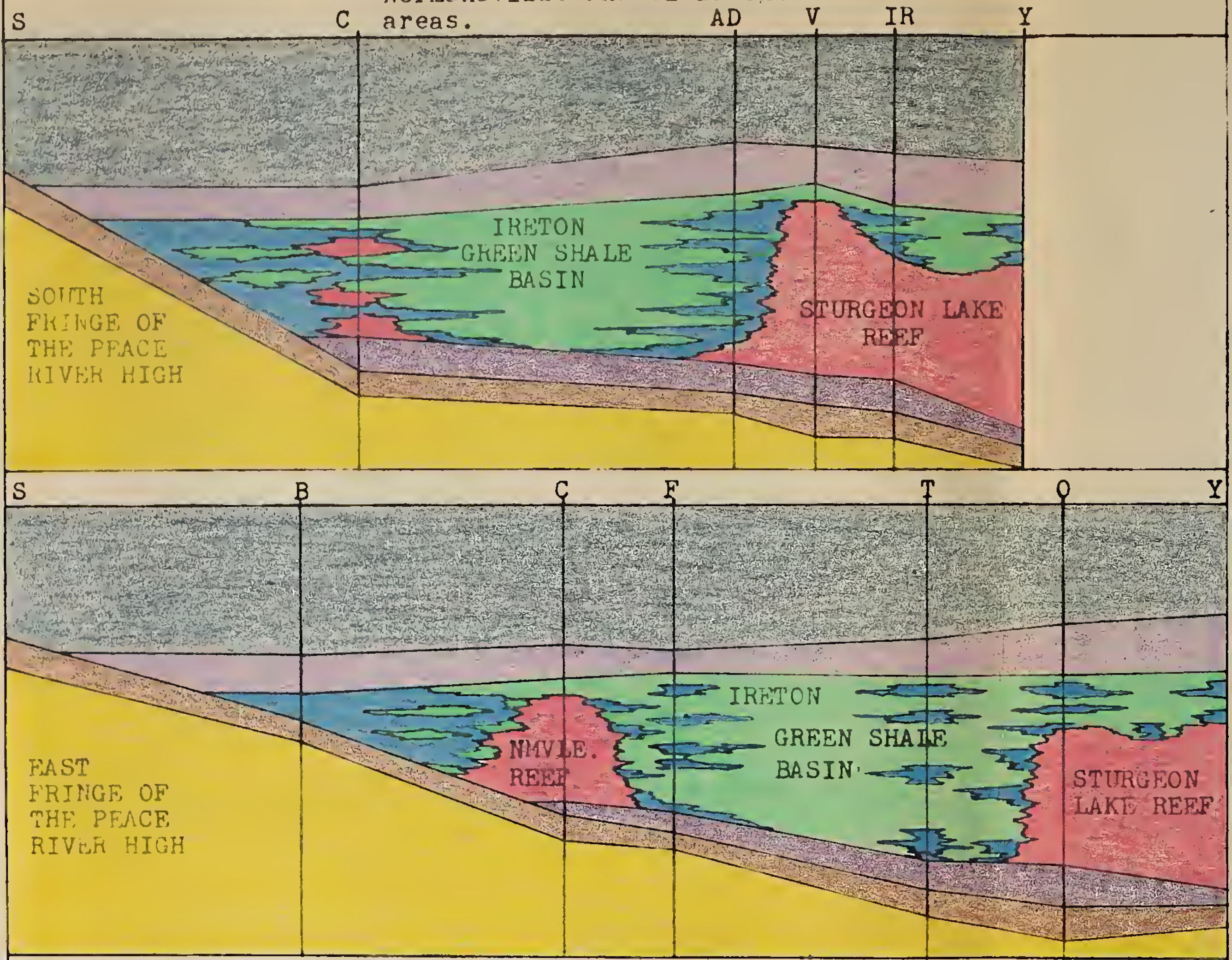
STRATIGRAPHIC CROSS SECTIONS:

Showing the tectonic elements and their effects of basinal configuration upon the stratigraphy of the Sturgeon Lake, Normandville and Clairmont areas.



LEGEND

Wabamun (Limestone).................. ▨
Winterburn (Dolomite)................ ▨
Woodbend - Ireton (Shale + Limestone).. ▨
- Reef (Dolomite)............ ▨
Cooking Lake + Beaverhill Lake (Limestone + Shale).. ▨
Granite Wash (Quartz + Feldspar)....... ▨
Pre-Cambrian (Granite)................ ▨

SCALE

Vertical.... 1" = 1000 ft.
Horizontal.. 1" = 16 mi.

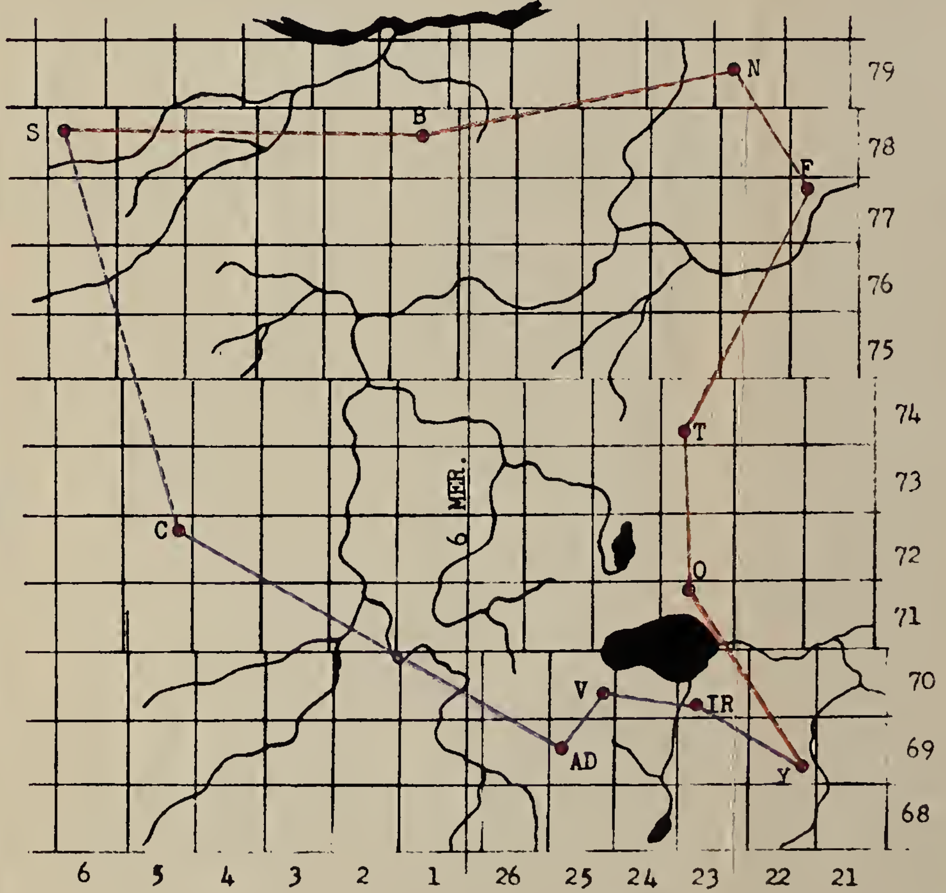
DATUM - top of Wabamun

FIGURE.3.

WELLS - in lines of section.

S .... Imperial Spirit River No. 1
C .... Imperial Clairmont No. 1
AD ... Amerada Crown "AD" 7-19
V .... Amerada Crown "V" F32-13
IR ... Amerada Indian Res. "A" 13-6
Y .... Amerada et al Crown "Y" 2-11
B .... Imperial Belloy No. 2
N .... Imperial Normandville No. 2
F .... Imperial Fahler No. 1
T .... Triad No. 12-16
O .... Amerada Crown "O" F33-32

BASE MAP - showing lines of section.



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[illegible]

[illegible]

[illegible]

[illegible]

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APPENDIX A

Chemical Composition

Tabulated results presented in stratigraphic sequence.

AMERADA CROWN "O" F33-32

Quantitative Determinations: Tabulated Results

Sample Number	Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Anhydrite (Percent)	Pyrite (Percent)	Insoluble Residue (Percent)	Percent Analytical Error and/or Undetermined Minerals	Ca/Mg Ratio
0-1	-6268	77.7	12.8	0.2	0.3	6.7	2.6 ± 0.5	2.16
0-3	-6273	93.1	5.3	0.5	* 0.1	0.3	0.8 " 0.5	1.80
0-5	-6277	93.7	6.2	0.1	* 0.1	0.2	-0.2 " 0.5	1.82
0-7	-6283	94.3	3.9	0.6	0.2	0.5	0.7 " 0.5	1.74
0-9	-6290	89.8	8.3	1.8	0.1	0.7	-0.6 " 0.5	1.98
0-10	-6298	91.2	4.6	2.2	0.5	0.9	1.1 " 0.5	1.86
0-11	-6303	5.3	2.0	86.1	0.2	2.3	4.3 " 0.5	39.1
0-12	- 6309	63.9	7.8	24.7	0.5	1.7	1.9 " 0.5	2.88
0-14	-6314	77.8	8.4	11.1	1.2	2.4	0.3 " 0.5	2.28
0-16	-6319	74.7	6.7	16.2	0.3	1.6	0.8 " 0.5	2.41
0-20	-6325	93.4	4.8	1.5	* 0.1	0.6	-0.3 " 0.5	1.80
0-22	-6333	85.7	9.6	3.1	0.2	0.9	0.7 " 0.5	2.07
0-24	-6339	91.2	6.4	0.7	* 0.1	0.6	1.1 " 0.5	1.88
0-26	-6344	91.3	5.7	1.4	0.4	1.3	0.3 " 0.5	1.86
0-27	-6348	92.5	4.6	0.8	0.2	0.9	1.2 " 0.5	1.81

* less than

AMERADA ET AL CROWN "Y" 2-11

Quantitative Determinations: Tabulated Results

Sample Number	Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Anhydrite (Percent)	Pyrite (Percent)	Insoluble Residue (Percent)	Percent Analytical Error and/or Undetermined Minerals	Ca/Mg Ratio
Y-1	-6201	92.5	6.2	0.2	* 0.1	0.3	0.8 ± 0.5	1.85
Y-2	-6203	93.2	5.6	0.1	0.7	1.2	-0.1 " 0.5	1.82
Y-3	-6205	94.4	5.1	* 0.1	0.1	0.2	0.3 " 0.5	1.80
Y-4	-6207	91.8	5.7	* 0.1	0.8	1.1	1.4 " 0.5	1.79
Y-5	-6210	95.1	3.7	* 0.1	0.2	0.8	0.4 " 0.5	1.75
Y-6	-6212	87.6	7.3	0.3	0.1	0.7	4.1 " 0.5	1.93
Y-7	-6214	96.1	4.3	0.1	* 0.1	0.4	-0.9 " 0.5	1.77
Y-8	-6217	86.7	10.2	0.4	0.3	1.5	1.2 " 0.5	2.02
Y-9	-6221	87.4	9.7	0.4	* 0.1	0.9	1.7 " 0.5	1.99
Y-10	-6224	90.7	8.3	0.2	* 0.1	0.3	0.5 " 0.5	1.92
Y-11	-6228	83.6	11.5	1.7	0.9	2.1	1.1 " 0.5	2.11
Y-12	-6232	93.3	5.6	* 0.1	0.3	0.5	0.6 " 0.5	1.83
Y-13	-6241	95.4	3.9	* 0.1	0.3	0.8	-0.1 " 0.5	1.76
Y-14	-6247	85.3	5.8	6.8	0.5	1.8	0.4 " 0.5	2.06
Y-15	-6252	78.9	4.7	13.3	0.2	1.6	1.5 " 0.5	2.21
Y-16	-6259	94.6	3.7	0.2	* 0.1	0.4	1.1 " 0.5	1.75
Y-17	-6263	95.2	4.8	* 0.1	* 0.1	0.4	-0.4 " 0.5	1.77
Y-18	-6266	82.4	5.1	9.6	0.3	0.7	2.2 " 0.5	2.10
Y-19	-6272	83.3	7.5	8.9	0.1	0.8	-0.5 " 0.5	2.16
Y-20	-6280	56.6	6.3	34.3	0.4	1.7	1.1 " 0.5	3.44
Y-22	-6317	89.7	4.6	4.7	* 0.1	0.6	0.4 " 0.5	1.91
Y-23	-6321	91.3	3.4	3.2	* 0.1	0.5	1.6 " 0.5	1.83
Y-24	-6331	94.6	3.5	0.3	0.3	0.9	0.7 " 0.5	1.74
Y-25	-6335	94.3	3.7	0.3	* 0.1	0.7	1.0 " 0.5	1.73
Y-26	-6340	93.8	4.3	0.2	0.4	1.2	0.5 " 0.5	1.79
Y-27	-6352	95.2	3.6	* 0.1	* 0.1	0.3	0.9 " 0.5	1.72
Y-28	-6356	91.3	3.9	2.7	0.2	0.8	1.3 " 0.5	1.85

* less than

[illegible]

[illegible]

[illegible]

* [illegible]

IMPERIAL NORMANDVILLE NO. 2

Quantitative Determinations: Tabulated Results

Sample Number	Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Anhydrite (Percent)	Pyrite (Percent)	Insoluble Residue (Percent)	Percent Analytical Error and/or Undetermined Minerals	Ca/Mg Ratio
N-66	-4862	85.5	6.8	* 0.1	0.5	4.9	2.8 ± 0.5	1.90
N-67	-4867	87.9	7.8	0.2	0.1	3.7	0.4 " 0.5	1.92
N-69	-4878	86.6	10.7	* 0.1	0.1	2.9	-0.2 " 0.5	2.02
N-70	-4882	82.9	8.8	2.4	0.2	4.3	1.6 " 0.5	2.02
N-71	-4888	75.5	4.8	13.6	0.7	4.9	1.2 " 0.5	2.26
N-73	-4898	81.9	7.4	9.1	0.3	2.3	-0.7 " 0.5	2.17
N-75	-4909	70.7	8.5	16.3	0.1	3.6	0.9 " 0.5	2.53
N-78	-4923	82.9	11.7	1.7	0.6	4.3	-0.6 " 0.5	2.13
N-81	-4938	79.4	7.9	0.3	0.4	7.7	4.7 " 0.5	1.95
N-83	-4948	82.1	12.4	1.3	0.1	5.3	-1.1 " 0.5	2.16
N-85	-4957	83.5	6.3	0.2	* 0.1	8.4	1.6 " 0.5	1.88
N-87	-4967	92.5	4.8	0.2	0.4	3.7	-1.2 " 0.5	1.81
N-89	-4978	84.3	6.7	0.5	0.9	6.1	2.4 " 0.5	1.90
N-90	-4981	87.0	8.9	* 0.1	0.3	2.7	1.4 " 0.5	1.95
N-92	-4993	85.1	9.5	0.1	1.1	4.6	0.7 " 0.5	1.99
N-94	-5002	91.6	6.8	0.1	0.8	2.4	-0.9 " 0.5	1.87
N-96	-5013	89.2	7.3	* 0.1	0.5	1.7	1.8 " 0.5	1.91
N-98	-5021	92.2	6.1	* 0.1	0.3	1.5	0.2 " 0.5	1.84
N-99	-5027	85.3	8.2	0.2	1.6	6.7	-0.4 " 0.5	2.13
N-100	-5032	90.7	5.8	0.1	* 0.1	2.3	1.1 " 0.5	1.83
N-101	-5038	84.4	6.6	6.4	0.3	3.1	-0.5 " 0.5	2.06
N-102	-5043	88.1	5.1	0.6	* 0.1	3.8	2.4 " 0.5	1.84
N-103	-5048	89.1	4.6	0.1	0.2	4.5	1.7 " 0.5	1.81

* less than

IMPERIAL CLAIRMONT NO. 1

Quantitative Determinations: Tabulated Results

Sample Number	Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Anhydrite (Percent)	Pyrite (Percent)	Insoluble Residue (Percent)	Percent Analytical Error and/or Undetermined Minerals	Ca/Mg Ratio
C-8	-8264	73.7	18.1	0.4	0.7	5.3	2.5 ± 0.5	24.1
C-8A	-8265	77.1	16.5	0.1	0.8	6.5	-0.2 " 0.5	22.8
C-9	-8265	82.5	11.9	0.2	0.4	4.7	0.7 " 0.5	2.08
C-10	-8268	79.6	13.4					

AMERADA CROWN "AD" 7-19

Quantitative Determinations: Tabulated Results

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)	Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-6902	12	73	15	-7162	4	69	27
-6912	17	68	14	-7172	8	76	16
-6922	11	81	8	-7182	11	66	23
-6932	7	80	13	-7192	7	79	14
-6942	4	76	20	-7202	7	83	10
-6952	9	82	9	-7212	3	71	26
-6962	6	86	8	-7222	6	83	11
-6972	6	87	7	-7232	4	91	5
-6982	3	83	14	-7242	12	82	6
-6992	10	67	23	-7252	8	69	23
-7002	7	64	29	-7262	5	79	16
-7012	4	83	13	-7272	11	80	9
-7022	6	89	5	-7282	8	73	19
-7032	3	88	9	-7292	3	89	8
-7042	1	92	7	-7302	7	86	7
-7052	2	93	5	-7312	6	90	4
-7062	6	83	11	-7322	3	78	19
-7072	5	83	12	-7332	5	84	11
-7082	2	79	19	-7342	10	76	14
-7092	7	73	20	-7352	12	81	7
-7102	3	68	29	-7362	9	83	8
-7112	3	76	21	-7372	4	75	21
-7122	8	58	34	-7382	4	80	16
-7132	13	74	13	-7392	2	81	17
-7142	4	78	18	-7402	5	73	22
-7152	7	81	12	-7412	3	80	17

AMERADA CROWN "AD" 7-19

Quantitative Determinations: Tabulated Results
(Cont'd)

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-7422	2	43	55
-7432	2	56	42
-7442	1	63	36
-7452	4	60	36
-7462	3	73	24
-7472	6	66	28
-7482	2	53	45
-7492	3	68	29
-7502	3	78	19
-7512	7	69	24
-7522	4	59	37
-7532	6	47	47
-7542	9	66	25
-7552	5	57	38
-7562	7	80	13
-7572	3	76	21
-7582	2	58	40
-7592	8	63	29
-7602	7	81	12
-7612	10	83	7
-7622	2	37	61
-7632	2	49	49
-7642	3	56	41
-7652	3	61	36
-7662	2	53	45
-7672	1	64	35
-7682	4	57	39
-7692	7	63	30
-7702	9	61	30
-7712	6	73	21
-7722	5	76	19
-7732	11	58	31
-7742	12	62	26
-7752	7	53	40
-7762	3	62	35
-7772	6	71	23
-7782	3	67	30
-7792	2	75	23
-7802	9	80	11
-7812	4	63	33
-7822	2	43	55
-7832	10	76	14
-7842	3	61	36
-7852	2	59	39
-7862	2	47	51
-7872	1	39	60
-7882	5	74	21
-7892	6	76	18
-7902	6	86	8
-7912	9	81	10
-7922	7	76	17
-7932	8	77	15

AMERADA CROWN "AD" 7-19

Quantitative Determinations: Tabulated Results

(Cont'd)

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-7942	3	58	39
-7952	2	43	55
-7962	2	59	39
-7972	4	71	25
-7982	9	75	16
-7992	13	81	6
-8002	11	84	5
-8012	17	72	11
-8022	24	63	13
-8032	46	47	7
-8042	37	53	10
-8052	26	60	14
-8062	33	59	8
-8072	41	43	16
-8082	19	73	8
-8092	14	76	10
-8102	17	68	15
-8112	41	38	21
-8122	57	31	12
-8132	26	70	4
-8142	17	78	5
-8152	13	81	6
-8162	7	66	27
-8172	11	80	9
-8182	16	67	17
-8192	12	81	7
-8202	8	63	29
-8212	17	66	17
-8222	5	56	39

AMERADA CROWN "V" 32-13

Quantitative Determinations: Tabulated Results

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)	Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-6336	87	6	6	-6596	89	7	4
-6346	75	13	12	-6606	82	7	11
-6356	79	16	5	-6616	93	4	3
-6366	73	14	13	-6626	96	2	2
-6376	52	43	5	-6636	88	7	5
-6386	44	51	5	-6646	93	4	3
-6396	66	25	9	-6656	93	4	3
-6406	55	33	12	-6666	91	5	4
-6416	46	48	6	-6676	87	9	2
-6426	58	33	9	-6686	82	11	7
-6436	43	51	6	-6696	85	9	6
-6446	63	32	5	-6706	78	13	9
-6456	58	33	9	-6716	83	11	6
-6466	83	12	5	-6726	85	10	5
-6476	76	13	11	-6736	91	5	4
-6486	63	24	13	-6746	92	5	3
-6496	58	28	4	-6756	63	24	13
-6506	46	49	5	-6766	67	28	15
-6516	36	58	6	-6776	58	33	9
-6526	56	41	3	-6786	63	21	16
-6536	37	60	3	-6796	46	34	20
-6546	64	33	3	-6806	33	59	8
-6556	55	43	2	-6816	37	50	13
-6566	33	61	6	-6826	34	58	8
-6576	82	13	5	-6836	62	33	5
-6586	62	34	4	-6846	46	39	5

AMERADA CROWN "V" 32-13

Quantitative Determinations: Tabulated Results
(Cont'd)

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-6856	47	46	7
-6866	58	35	7
-6876	55	40	5
-6886	41	42	17
-6896	42	48	10
-6906	43	43	14
-6916	39	52	9
-6926	59	35	6
-6936	78	19	3
-6946	83	12	5
-6956	89	4	7
-6966	92	4	4
-6976	93	5	2
-6986	90	5	5
-6996	95	2	3
-7006	96	2	2
-7016	65	23	12
-7026	76	19	5
-7036	85	9	6
-7046	91	6	3
-7056	95	3	2
-7066	93	3	4
-7076	94	4	2
-7086	92	5	3
-7096	95	2	3
-7106	91	4	5
-7116	95	1	4
-7126	93	3	4
-7136	94	3	3
-7146	88	7	5
-7156	83	6	11
-7166	85	8	7
-7176	89	3	8
-7186	84	12	4
-7196	82	15	3
-7206	87	9	4
-7216	78	16	6
-7226	85	9	6
-7236	88	8	4
-7246	90	7	3
-7256	86	9	5
-7266	72	13	15
-7276	87	7	6
-7286	80	12	8
-7296	88	5	7
-7306	83	13	4
-7316	74	15	11
-7326	87	8	5
-7336	96	3	1
-7346	92	6	2
-7356	89	7	4
-7366	76	13	11

AMERADA CROWN "V" 32-13

Quantitative Determinations: Tabulated Results

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-7376	84	5	11
-7386	73	14	13
-7396	N.S.	-	-
-7406	87	7	6
-7416	82	10	8
-7426	81	8	11
-7436	92	2	6
-7446	91	4	5
-7456	93	3	4
-7466	87	6	7
-7476	93	4	3
-7486	91	4	5
-7496	89	7	4
-7506	86	7	7
-7516	93	5	2
-7526	64	25	11

AMERADA IND. RES. "A" 13-6

Quantitative Determinations: Tabulated Results

(Cont'd)

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-6298	9	67	24
-6308	31	56	13
-6318	38	58	4
-6328	13	76	11
-6338	19	64	17
-6348	43	41	16
-6358	52	45	3
-6368	33	58	9
-6378	24	68	8
-6388	26	53	11
-6398	17	58	25
-6408	19	66	15
-6418	11	67	22
-6428	9	74	17
-6438	8	69	23
-6448	3	68	29
-6458	4	77	19
-6468	24	63	13
-6478	32	65	2
-6488	43	51	6
-6498	47	46	7
-6508	28	57	5
-6518	21	67	12
-6528	14	71	15
-6538	11	78	11
-6548	10	73	17
-6558	18	70	12
-6568	29	59	12
-6578	15	67	18
-6588	27	62	11
-6598	48	43	9
-6608	68	23	9
-6618	73	19	8
-6628	53	38	9
-6638	64	22	14
-6648	43	36	21
-6658	53	33	14
-6668	65	28	7
-6678	68	26	6
-6688	53	31	16
-6698	78	14	8
-6708	76	15	9
-6718	N.S.	-	-
-6728	N.S.	-	-
-6738	N.S.	-	-
-6748	N.S.	-	-
-6758	N.S.	-	-
-6768	N.S.	-	-
-6778	N.S.	-	-
-6788	73	11	16
-6798	N.S.	-	-
-6808	N.S.	-	-

AMERADA IND. RES. "A" 13-6

Quantitative Determinations: Tabulated Results

(Cont'd)

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-6818	83	6	11
-6828	76	12	12
-6838	N.S.	-	-
-6848	N.S.	-	-
-6858	N.S.	-	-
-6868	63	18	19
-6878	78	11	11
-6888	N.S.	-	-
-6898	73	18	9
-6908	N.S.	-	-
-6918	63	24	13
-6928	71	25	4
-6938	61	19	20
-6948	N.S.	-	-
-6958	N.S.	-	-
-6968	N.S.	-	-
-6978	N.S.	-	-
-6988	58	31	11
-6998	59	28	13
-7008	N.S.	-	-
-7018	N.S.	-	-
-7028	57	32	11
-7038	64	12	24
-7048	N.S.	-	-
-7058	81	13	6
-7068	N.S.	-	-
-7078	N.S.	-	-
-7088	56	35	9
-7098	64	25	11
-7108	66	27	7
-7118	73	19	8
-7128	46	38	16
-7138	65	23	12
-7148	74	18	8
-7158	47	38	15
-7168	59	33	8
-7178	78	11	11
-7188	63	26	11
-7198	84	9	7
-7208	76	14	10
-7218	63	30	7
-7228	88	4	8
-7238	69	16	15
-7248	N.S.	-	-
-7258	53	38	9
-7268	65	29	6
-7278	N.S.	-	-
-7288	N.S.	-	-
-7298	41	46	13
-7308	57	38	5
-7318	78	14	8
-7328	73	19	8

AMERADA IND. RES. "A" 13-6

Quantitative Determinations: Tabulated Results

(Cont'd)

Depth (Sub-Sea)	Dolomite (Percent)	Limestone (Percent)	Insol. Res. (Percent Diff.)
-7338	71	21	8
-7348	63	28	9
-7358	78	16	6
-7368	56	29	15
-7378	44	32	24
-7388	36	45	19
-7398	41	37	22
-7408	63	23	14
-7418	49	30	21
-7428	37	38	25
-7438	27	43	30
-7448	36	44	20
-7458	23	46	31
-7468	19	53	28
-7478	13	68	19
-7488	28	56	16
-7498	12	47	41

APPENDIX B

PHOTOGRAPHED SKETCHES OF FOSSIL REMNANTS FROM THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT REEF COMPLEXES

The following photographed sketches were made of fossil structures, fragments and remnants observed from slightly stained polished sections under reflected light. The sketches of the organisms have been idealized to some extent and outstanding features emphasized in order that they might be portrayed photographically. If, for example, a partial hydrocoralline structure, consisting of laminae and radial pillars, lost its definition as it transcended into a shadow outline, the skeleton was reconstructed as it appeared to reflect its character from the shadowed outline.

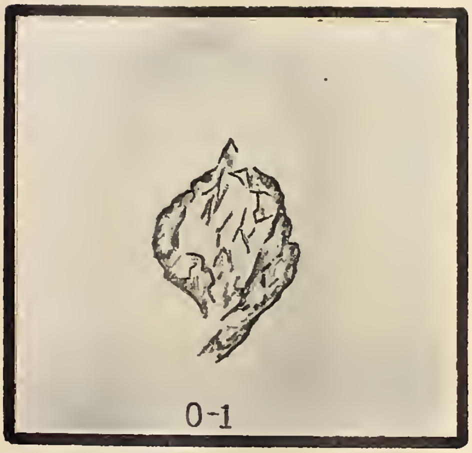
As previously stated, the main purpose in searching for fossil remnants was to establish whether the reef complexes, at Sturgeon Lake in particular, were definitely of organic origin. The observations, as recorded, establish this fact but no further interpretation, even of genus, was attempted particularly as far as correlation is concerned.

Identification as to Phylum was all that was generally attempted as the effects of dolomitization, compaction, leaching and replacement had extensively altered the organisms.

Specimen numbers refer to those used in the recording of textural features; (see Tabulated and Graphic Data - pocket insert I.A.).

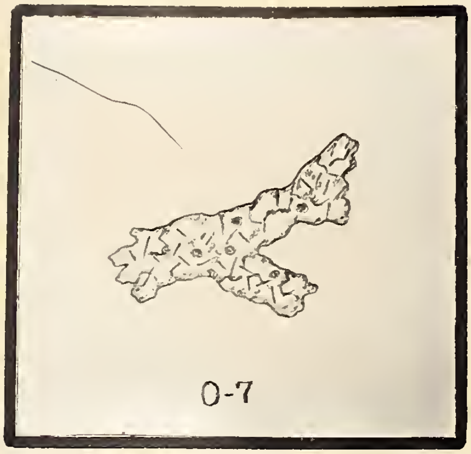
SKETCHES OF

FOSSIL REMNANTS FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA CROWN "O" F33-32 WELL



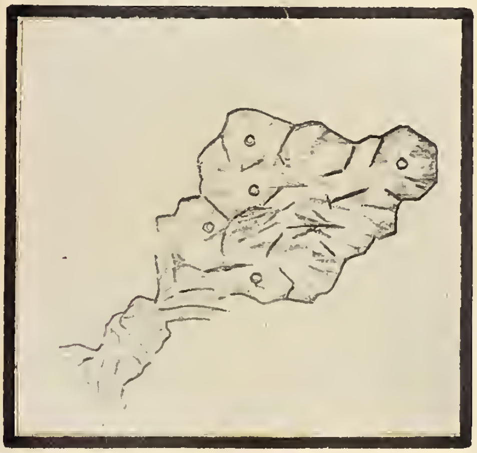
0-1 X3.

Outline of a gastropod showing a rude outline of the spire and body whorls.



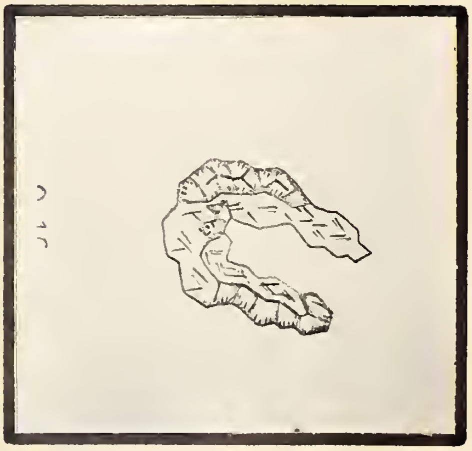
0-7 X3.

Bryozoan fragment showing skeletal outline, zoaecial openings and dendroidal pattern.



0-12 X3.

Altered remains of a crinoid calyx (?) and columnal (?) showing pentagonal outline of the plates.



0-16 X3.

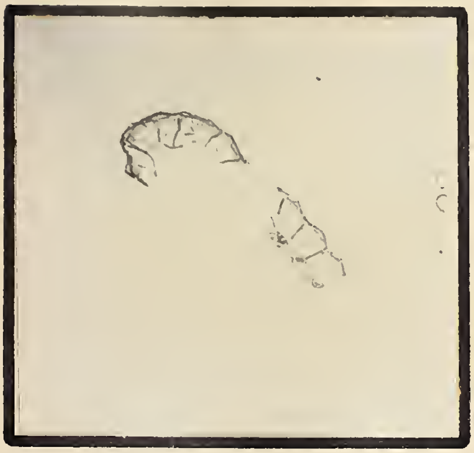
Indeterminable organic remnant suggestive of a tabulate coral.

PLATE I

SKETCHES OF

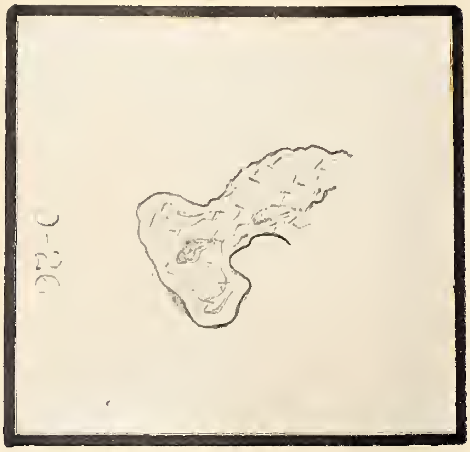
FOSSIL REMNANTS FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA CROWN "O" F33-32 WELL

(Cont'd)



0-22 X3.

Remnant laminae and radial pillars of a hydrocoralline.



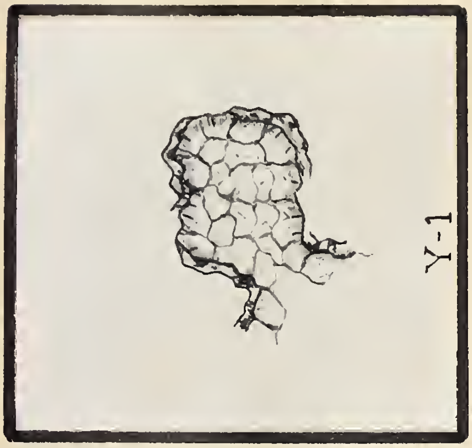
0-26 X3.

Shadowed outline of an algal remnant showing laminate structure and shadowed outline of nuclei (?).

PLATE 2

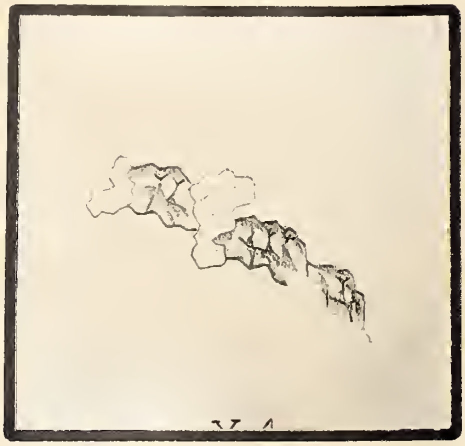
SKETCHES OF

FOSSIL REMNANTS FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA ET AL CROWN 'Y' 2-11 WELL



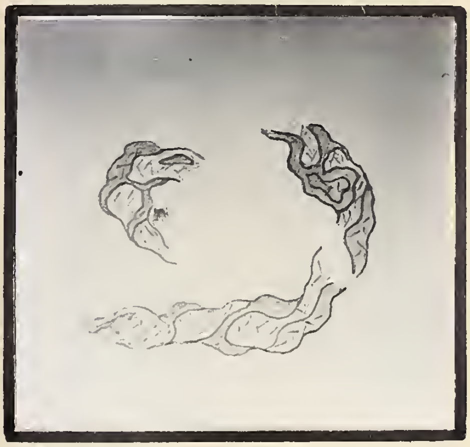
Y-1 X3.

Lobular remnant, showing fragments of epithica (?) and internal cellular structure.



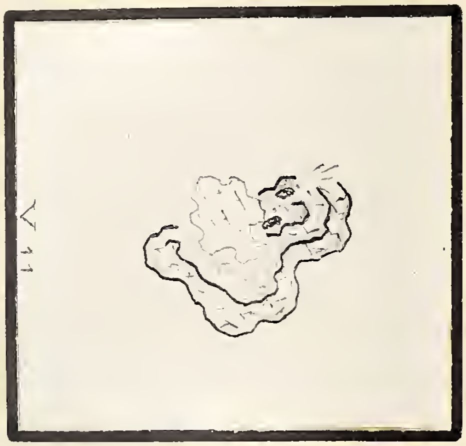
Y-4 X3.

Coralline structure showing tabulae and occasional septa (?) which has been replaced by pyrite and calcite.



Y-7 X3.

Possible distorted remnant of an umbilicate gastropod showing segments of the body whorls.



Y-11 X3.

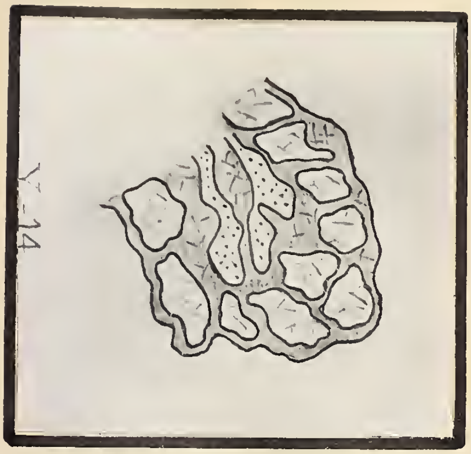
Algal remnant which has been partially altered and replaced by pyrite. Shadowed outlines of nuclei (?) are apparent.

PLATE 3

SKETCHES OF

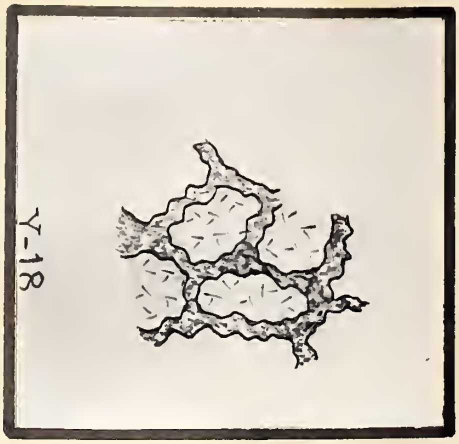
FOSSIL REMNANTS FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA ET AL CROWN "Y" 2-11 WELL

(Cont'd)



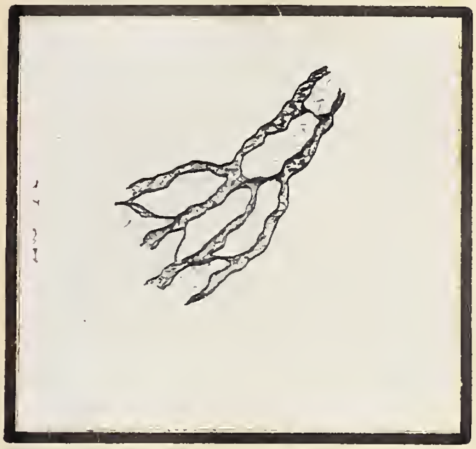
Y-14 X3.

Corallum structure basically similar to Plasmopora (a colonial coral).



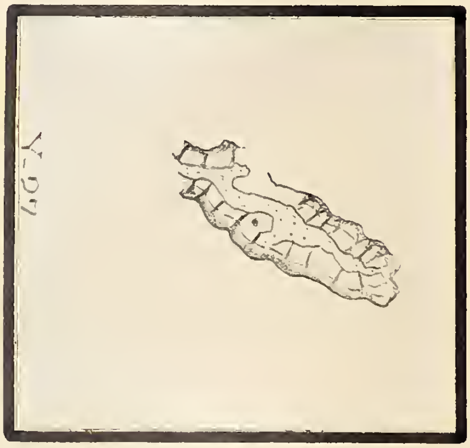
Y-18 X3.

A prismatic corallum structure of a colonial coral.



Y-23 X3.

Coralline structure with a reticulate cellular pattern similar to an elongate section of Stromatopora (a hydrocoralline).

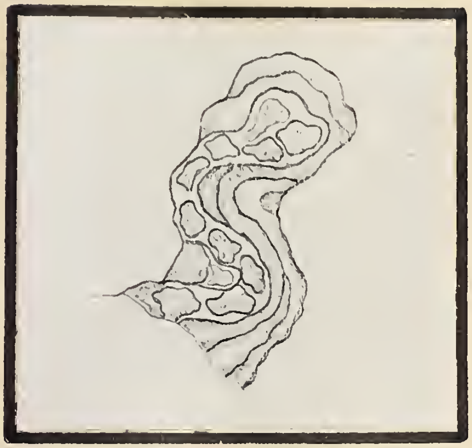


Y-27 X3

An indeterminable organism; similar to Bryozoa, (showing possible infrequent zooecial openings).

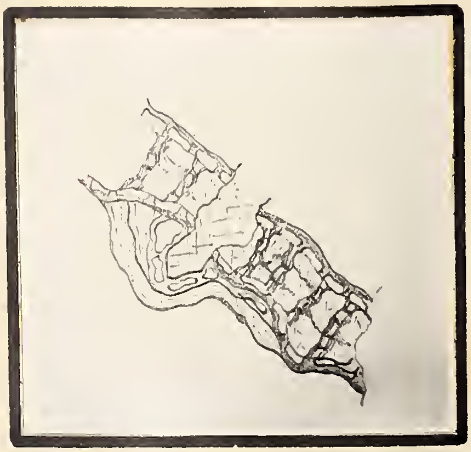
PLATE 4

SKETCHES OF
FOSSIL REMNANTS FROM THE UPPER DEVONIAN REEF COMPLEX OF THE IMPERIAL NORMANDVILLE NO. 2 WELL



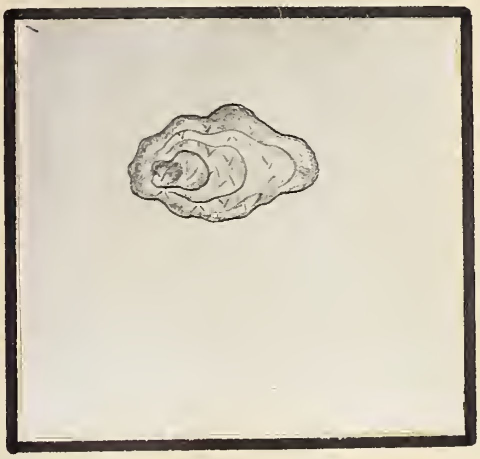
N-69 X3.

A coralline structure, showing wrinkled epithica, corallum and weak septa.



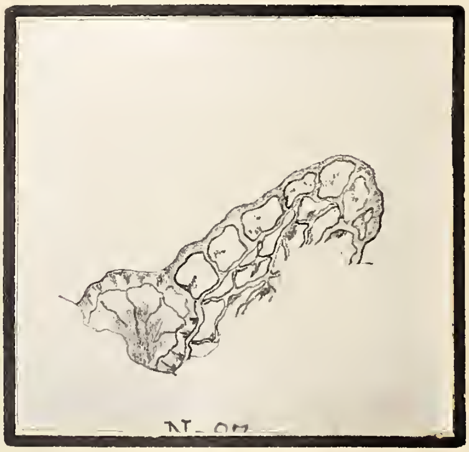
N-71 X3.

A coralline structure, similar to Stromatoporoidea, showing laminae, cellular structure and prominent radial pillars.



N-85 X3.

Symmetrical shadow outline of an algal remnant showing laminate structure.



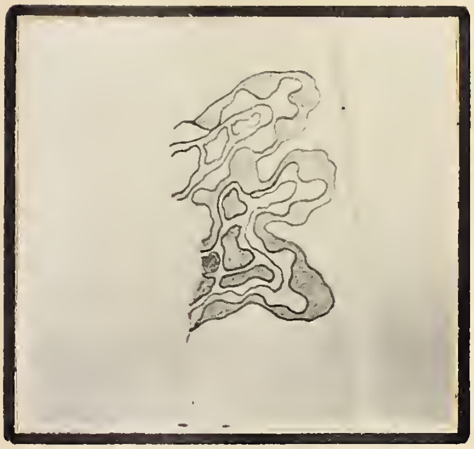
N-87 X3.

Columnal structure, similar to Stromatoporoidea, growing against a corallite, showing 13 web septa and 4 long septa in the half cross section.

PLATE 5

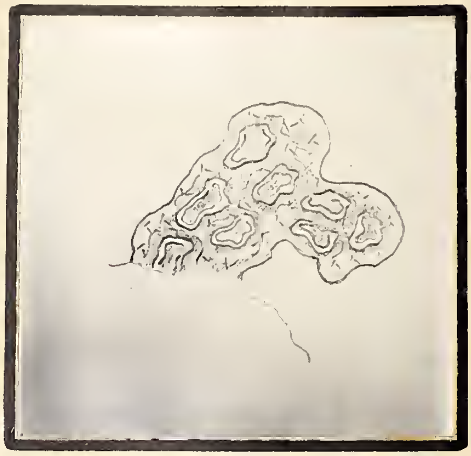
SKETCHES OF FOSSIL REMNANTS FROM THE UPPER DEVONIAN REEF COMPLEX OF THE IMPERIAL NORMANDVILLE NO. 2 WELL

(Cont'd)



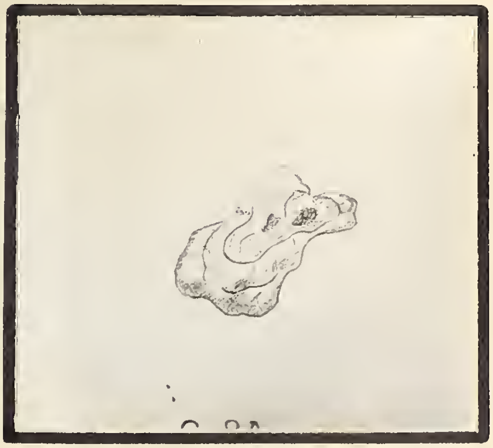
N-98 X3.

Bryozoan or similar coralline structure which has been highly distorted.



N-101 X3.

Distorted structure similar to Bryozoa, showing an apparent zoaria segment with elongated zooecial openings.



C-8A X3.

Symmetrical outline of an algal remnant showing an indistinct shadow of the laminated structure.

PLATE 6

APPENDIX C

PHOTOGRAPHS OF REPRESENTATIVE TEXTURES AND DIAGNOSTIC FEATURES IN THIN SECTIONS OF THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT REEF COMPLEXES

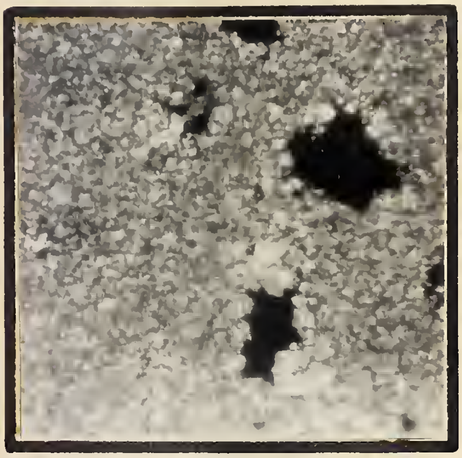
The following photographs were made of representative textures or of particularly diagnostic features found in the examination of thin sections from the above reefoid sediments. A certain number of insoluble residues were also reproduced photographically to present a conception of their general character only, since they were so impoverished in heavy minerals as to render their investigation ineffectual.

Specimen numbers refer to those used in the recording of textural features; (see Tabulated and Graphic Data - pocket insert 1.A.).

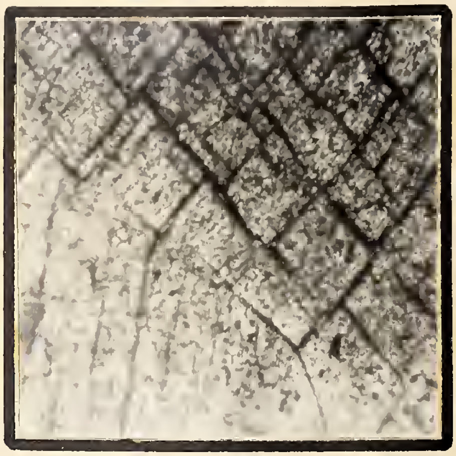
PHOTOGRAPHS OF

TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX

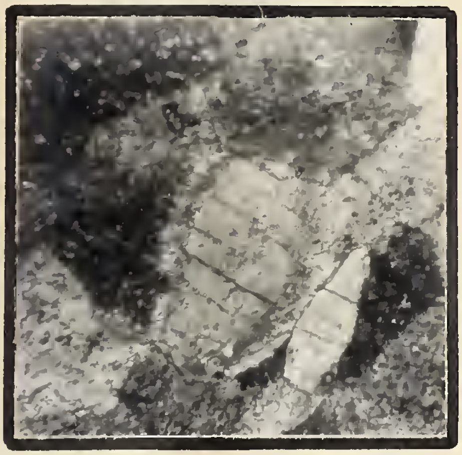
OF THE AMERADA CROWN "O" F33-32 WELL



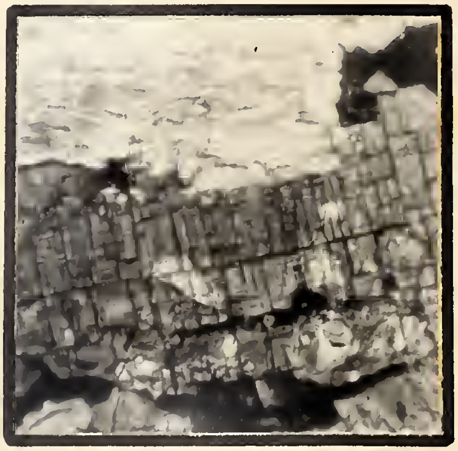
0-1 X80.
Features: A fine granoblastic texture tending to be cryptocrystalline in part, also a few small vugs infilled with calcite.



0-5 X80.
Features: Holocrystalline texture of dolomite showing good rhombohedral cleavage. Fractures are infilled with fine gray-black silt.



0-9 X80.
Features: A porphyroblastic texture of dolomite and anhydrite showing crystal zoning.



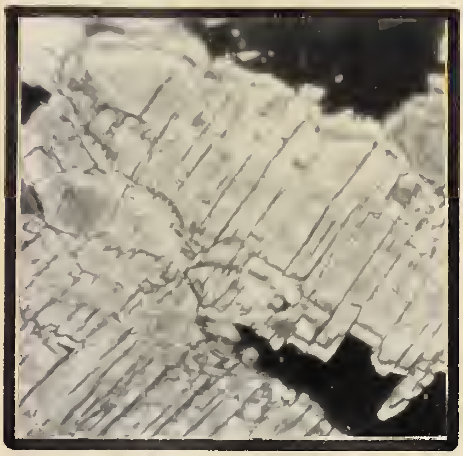
0-11 X80.
Features: Anhydrite showing parallel cleavage and fibrous structures.

PLATE 7

PHOTOGRAPHS OF

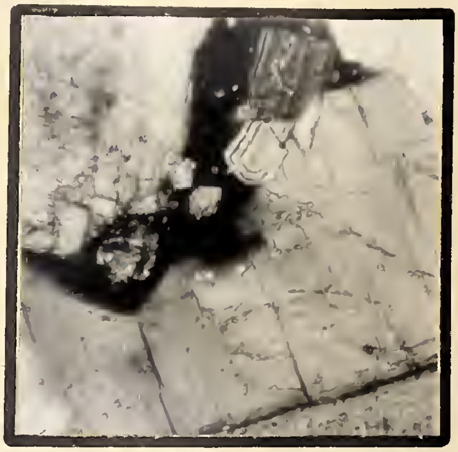
TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA CROWN "O" F33-32 WELL

(Cont'd)



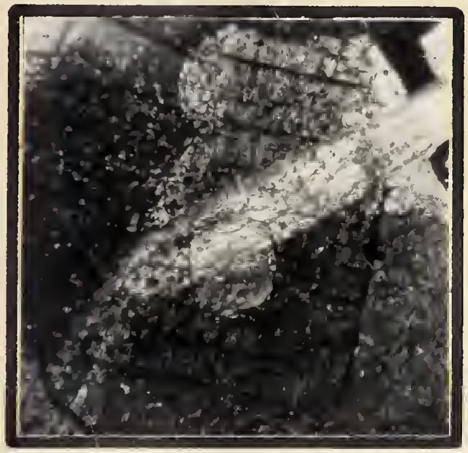
0-11 X80. X-N

Features: Symmetrical outline of a possible replacement form.



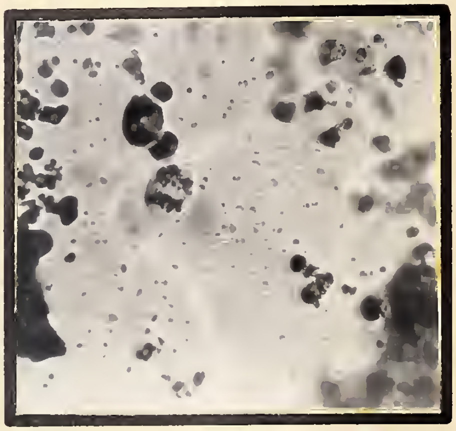
0-16 X80. X-N

Features: Calcite and anhydrite infilling in a leached dolomite vug.



0-20 X80.

Features: A mozaic of coarse, holocrystalline dolomite with included crystal overgrowths of quartz and calcite. Shown also, is a fibrous anhydrite structure.



0-24a X80.

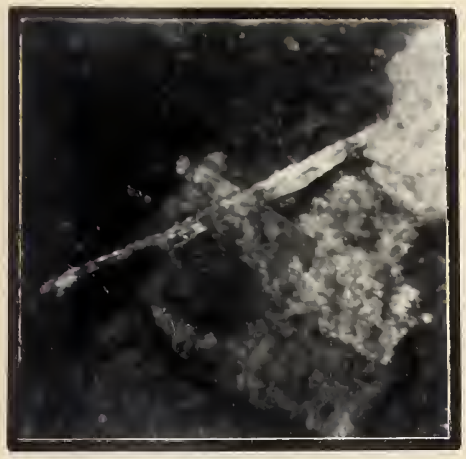
Features: Insoluble residue of fine, gray-black silt with rare anhedral crystals of allogenic quartz.

PLATE 8

PHOTOGRAPHS OF

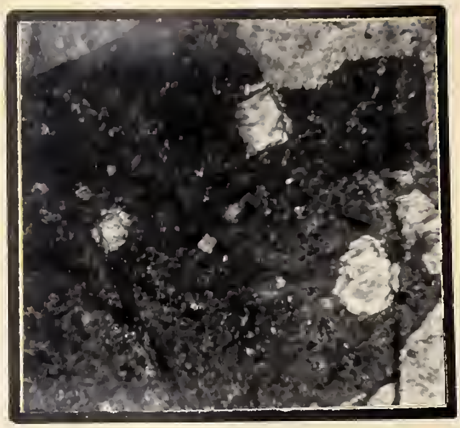
TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA CROWN "O" F33-32 WELL

(Cont'd)



0-24 X80.

Features: Silt clouded dolomite replaced by subhedral crystalline and fibrous anhydrite.



0-27 X80. X-N

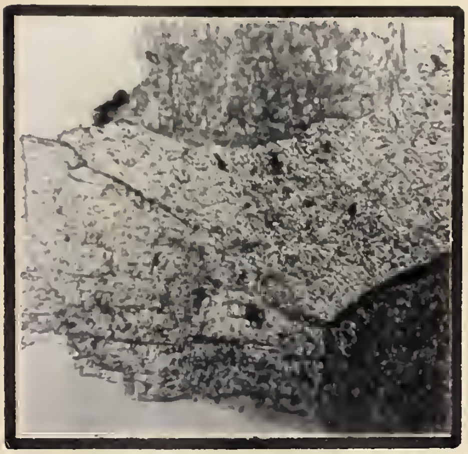
Features: Coarse holocrystalline texture of dolomite; clouded with fine silt and organic debris. Shown also, are inclusions of calcite, quartz and garnet.

PLATE 9

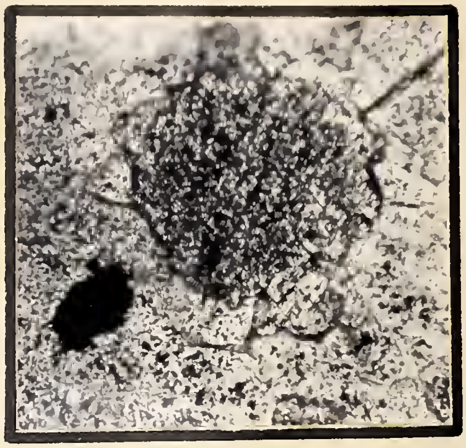
PHOTOGRAPHS OF

TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX

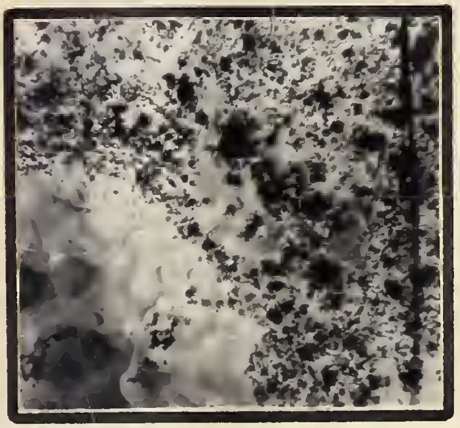
OF THE AMERADA ET AL CROWN "Y" 2-11 WELL



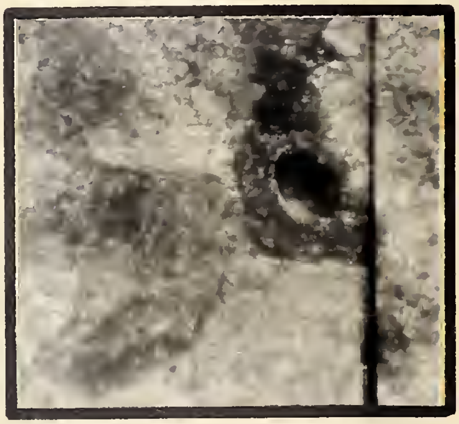
Y-2 X80.
Features: Infilling of secondary fractures with organic debris which is also included in the dolomite crystals.



Y-3 X80.
Features: Intense clouding of dolomite texture by fine silt - a cyclic condition.



Y-5a X80.
Features: Insoluble residue showing fine gray-black silt and fine anhedral quartz grains.



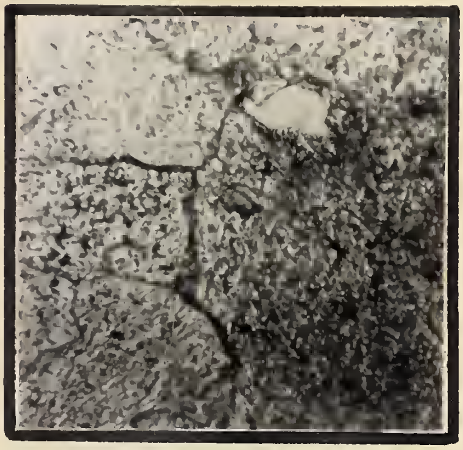
Y-10 X80.
Features: Crystal zoning and a fossil replacement structure.

PLATE 10

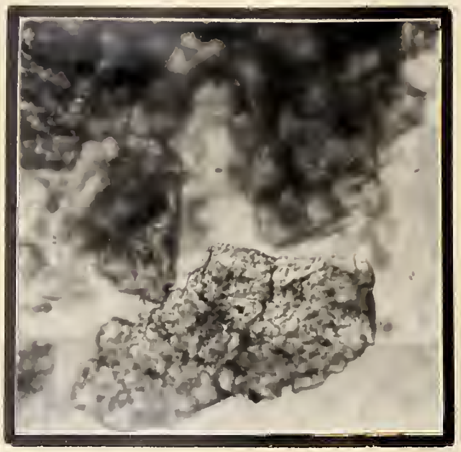
PHOTOGRAPHS OF

TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA ET AL CROWN "Y" 2-11 WELL

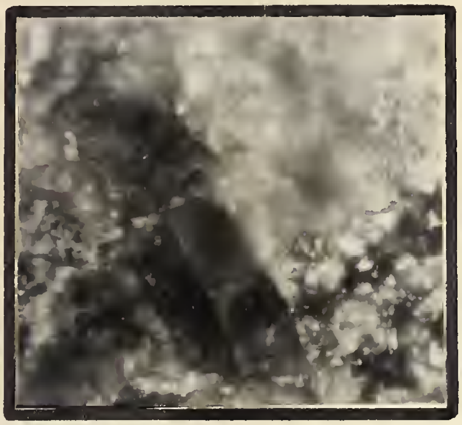
(Cont'd)



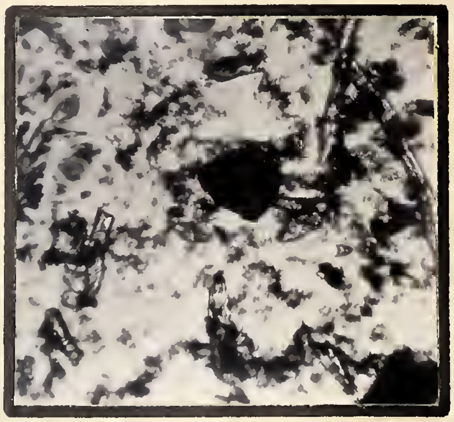
Y-13 X80.
Features: Granoblastic mozaic of dolomite, showing a fine, subhedral quartz crystal inclusion.



Y-16 X80.
Features: Leaching of silt clouded dolomite and subsequent infilling with calcareous silt and calcite.



Y-17 X80.
Features: Merocrystalline texture of dolomite with traces of allogenic quartz and garnet;also a crystal of dolomite showing repeated twinning.



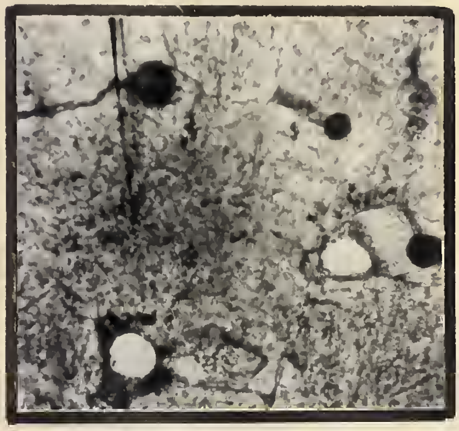
Y-19a X80. X-N
Features: Insoluble residue showing a fine, subhedral crystal of garnet; traces of anhydrite and a fine gray-black silt. Ground mass.

PLATE 11

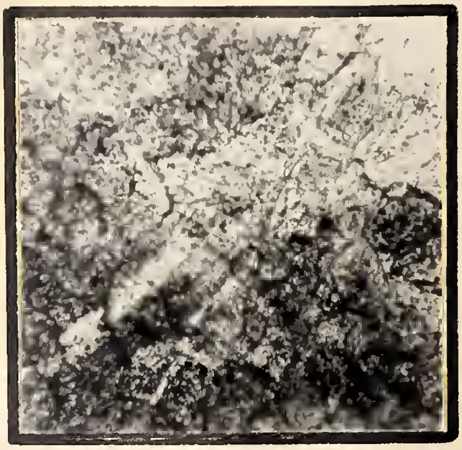
PHOTOGRAPHS OF

TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE AMERADA ET AL CROWN "Y" 2-11 WELL

(Cont'd)



Y-23 X80.
Features: Merocrystalline texture of dolomite with partial inclusions of organic debris and fine, anhedral quartz crystals.

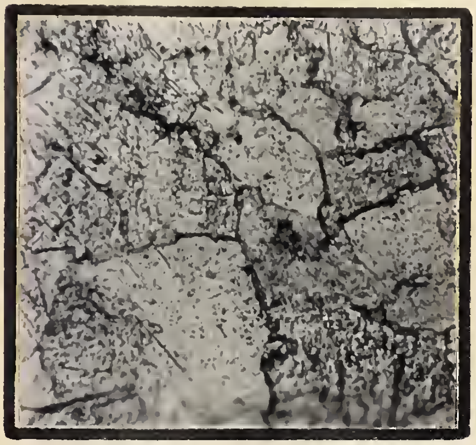


Y-26 X80.
Features: Merocrystalline texture of fractured dolomite, showing a fibrous structure of secondary anhydrite.

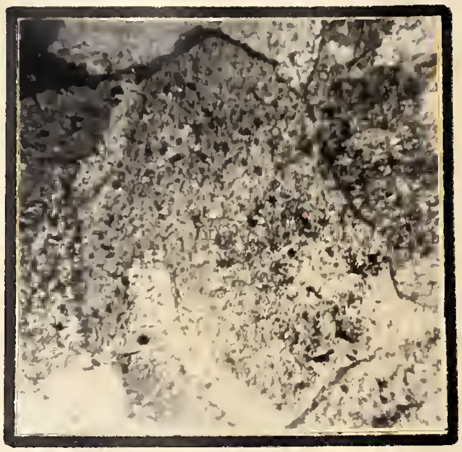
PLATE 12

PHOTOGRAPHS OF

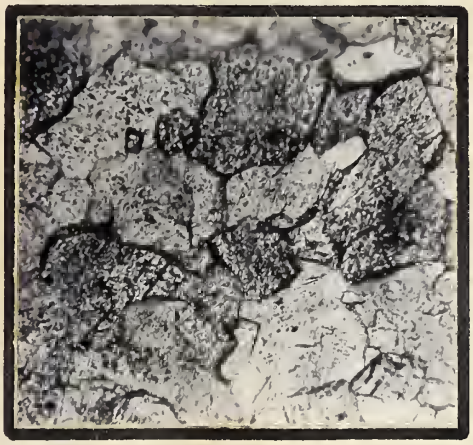
TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE IMPERIAL NORMANDVILLE NO. 2 WELL



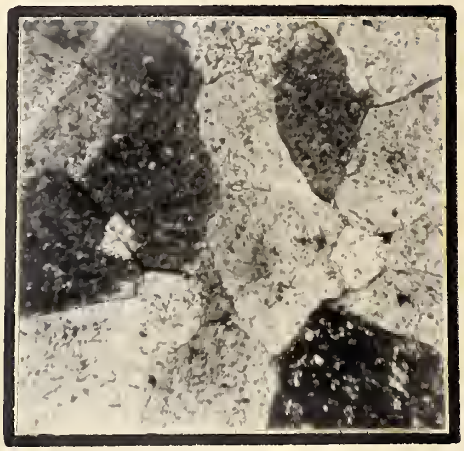
N-70 X80.
Features: Porphyroblastic texture of euhedral dolomite crystals which are clouded by gray-black silt.



N-78 X80.
Features: Inclusions of feldspar and quartz; preponderance of organic debris.



N-89 X80.
Features: Porphyroblastic texture of dolomite with inclusions of holohedral calcite and anhedral quartz.



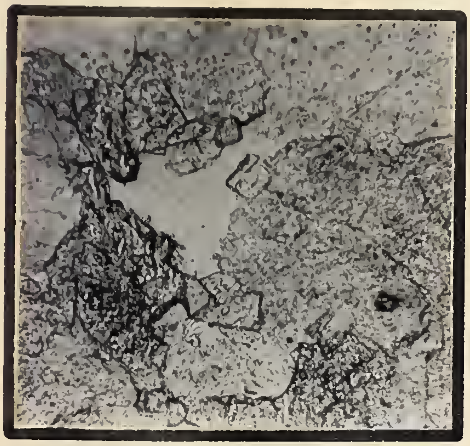
N-92 X80.
Features: Coarse merocrystalline aggregate of dolomite and limestone with inclusions of subhedral crystals of quartz and garnet.

PLATE 13

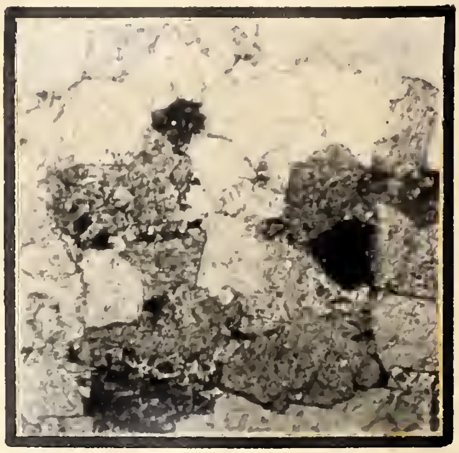
PHOTOGRAPHS OF

TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE IMPERIAL NORMANDVILLE NO. 2 WELL

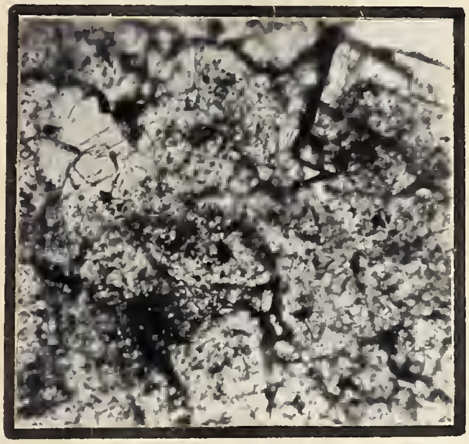
(Cont'd)



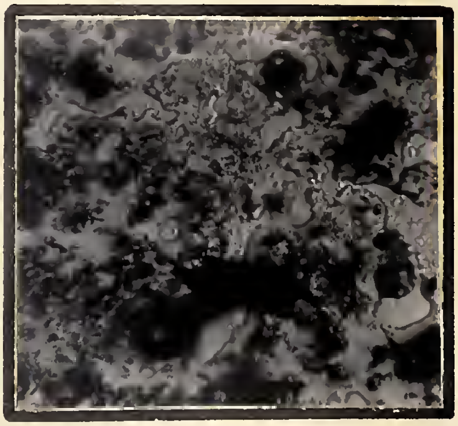
N-94 X80.
Features: Fine anhedral quartz inclusions; prominent silty matrix; anhydrite infilling in leached vugs.



N-99 X80.
Features: Merocrystalline mozaic of dolomite with coarser remnants of organic debris.



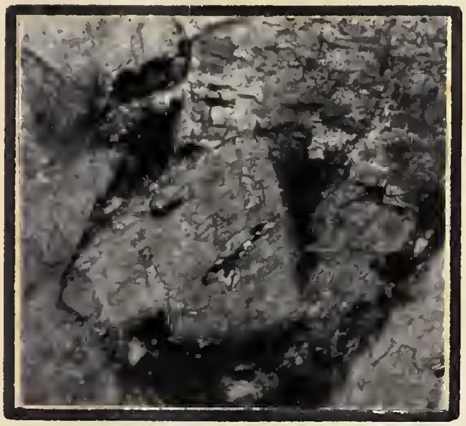
N-103 X80.
Features: Prominent fracture infilling with fine gray-black silt; traces of fine anhedral quartz crystals.



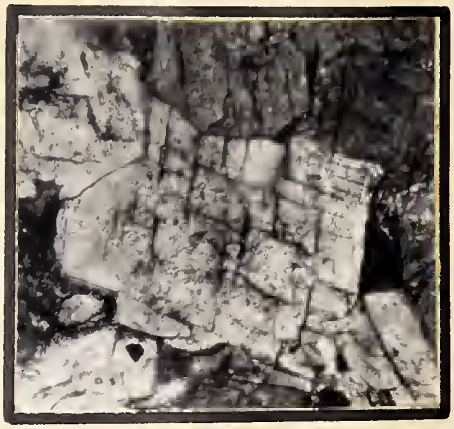
N-73a X80.
Features: Insoluble residue of fine gray-black silt; also, showing fine anhedral crystals of quartz.

PLATE 14

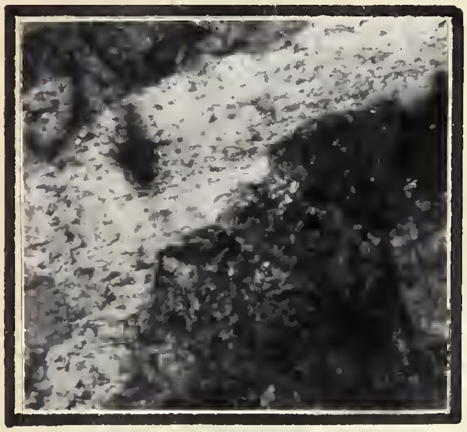
PHOTOGRAPHS OF TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE IMPERIAL CLAIRMONT NO. 1 WELL



C-8 X80.
Features: Porphyroblastic texture of dolomitic limestone, showing a prominent matrix of silt and organic debris.



C-8A X80.
Features: Granoblastic mozaic of dolomite, showing good rhombohedral cleavage.



C-9 X80.
Features: Cryptocrystalline limestone and silt infilling a fracture form. Traces of organic debris.

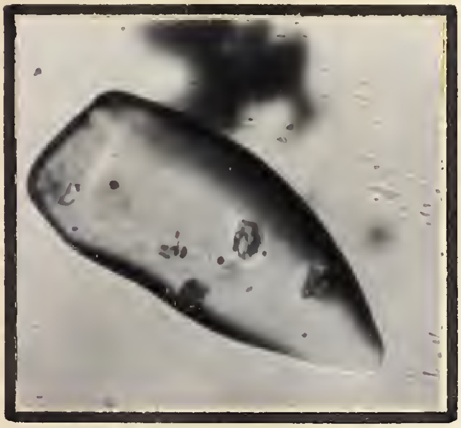
Clairmont: X1.5
Features: Rude bedding resulting from textural variations and facies changes.

PLATE 15

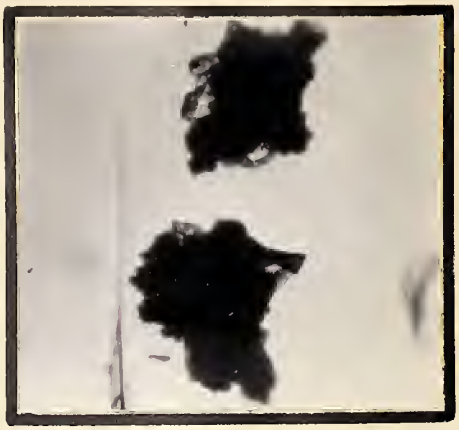
PHOTOGRAPHS OF

TEXTURES AND STRUCTURES FROM THE UPPER DEVONIAN REEF COMPLEX OF THE IMPERIAL CLAIRMONT NO. 1 WELL

(Cont'd)



C-8Aa X80.
Features: Anhedral quartz crystal showing poikilitic inclusions and crystal growth.



C-9a X80.
Features: Aggregates of authigenic feldspar and subhedral quartz crystals in a matrix of gray-black silt and clay.

PLATE 16

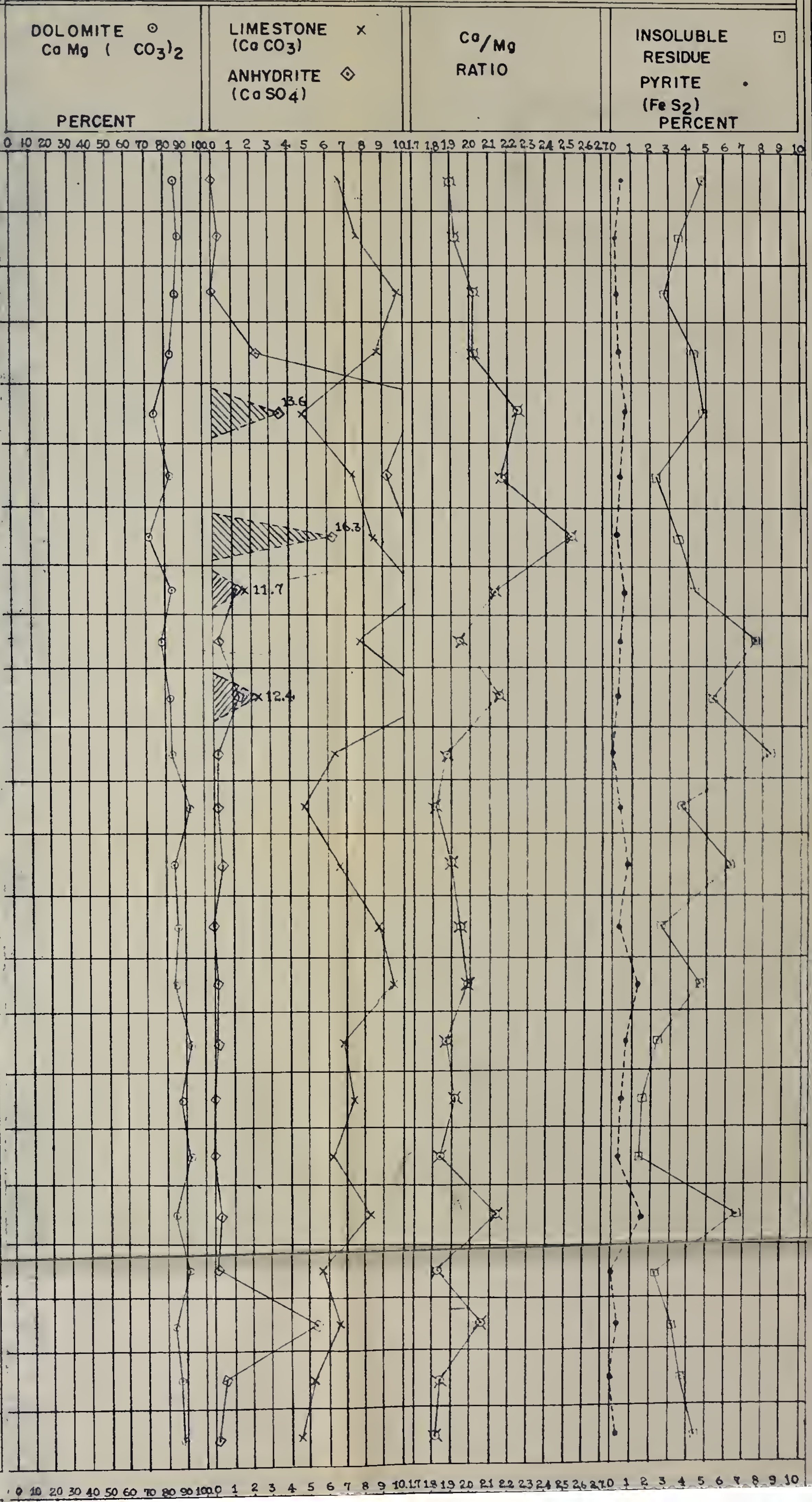
DIAGENIC EFFECTS AND DIAGNOSTIC FEATURES OF THE STURGEON LAKE, NORMANDVILLE AND CLAIRMONT REEF

WELL		GENERAL COLOR OF AGGREGATE	MICROSCOPIC EXAMINATION: POLISHED AND THIN SECTIONS.								MATRIX CONSTITUENTS AND INTERSTITIAL INCLUSIONS (ORGANIC – INORGANIC); AUTHIGENIC AND / OR ALLOGENIC	FOSSILS AND FOSSIL REMNANTS	REMARKS: PARTICULAR DIAGENIC EFFECTS
			PREDOM. CRYSTAL SIZE			TEXTURE, STRUCTURES, INCLUSIONS (ORGANIC – INORGANIC) CRYSTAL GROWTHS, ZONED CRYSTALS AND TWINNING	SPECIAL FEATURES: CLEAVAGE, FRACTURE FORMS BEDDING, CONCRETIONARY VUGS	MATRIX:					
SPECIMEN NUMBER	DEPTH (SUB-SEA)		FINE	MEDIUM	COARSE			INCIPIENT (0-5%)	INTERMED (5-10%)	PRONOUNCED (10-15%)			
IMPERIAL NORMANDVILLE #2													
N-66	-4862	Medium gray and grading to buff-brn.		⊙		Massive, holocryst. dol. and dol.-ls. consisting of equigran. subhedral and anhedral cryst. aggregates. Trace of clear, anhed. qtz. inclus.	Rare, large vugs and sparse dendritic fracture forms (infill sec. minerals are calcite and trace of anhyd.)	▨	▨	▨	Dark gray and black, fine and crypto-cryst., calcareous and silty - containing gray-black, authigenic debris.	Fossil mould: impression of a small pelecyped - no characteristics preserved.	Recrystallization and the effects of compaction are apparent but not excessively so.
N-67	-4867	As above, tending to become more buff-brown.		⊙		Massive, holocryst. as above, tending to become more fine cryst. and more anhedral. Trace of zoning and polysynthetic twinning.	Poor rhombohedral cleavage; rare large, symmet. vugs. Infill as above. (Possible fossil replace.)	▨	▨		As above; somewhat more spasmodic. Similar interstitial inclusions.	Fibrous and crystalline organic structure.	Replacement of large fossil forms by calcite and minor authigenic pyrite and anhydrite is particularly predominant.
N-69	-4878	Medium gray and buff-brn. (Predom.)		⊙		Massive, holocryst. dol. and dol.-ls. consisting of equigran., euhedral to anhedral cryst. aggregates. Trace of clear anhed. qtz. inclus.	Poor rhombohedral cleavage; rare large, symmet. vugs infilled with lt. gray calcite and dolomite.	▨			Slightly less apparent due to less silt and gray-black authigenic organic debris.	Coralline structure similar to Favistella showing wrinkled epithica, corallum, and septa remnants.	Matrix cement is sparse and contains less authigenic organic debris. A few growth crystals can be observed.
N-70	-4882	Medium gray (Predom.) and buff-brown.		⊙		Massive, holocryst. dol., tending to merocryst. in part. Consisting of inequigran. subhedral and anhedral crystal aggregates.	Poor rhombohedral cleavage. Common, small, irratic vugs infilled with gray-white calcite.	▨	▨		Dark gray and black, fine and crypto-cryst., calcareous and silty matrix is more pronounced - similar interstitial debris.	Rare, small, symmetrical vugs infilled with calcite.	Effects of compaction are not as noticeable while matrix cement containing authigenic organic debris, and quartz is additive.
N-71	-4888	Medium gray and grading to buff-brn.		⊙		Massive, holocryst. and merocryst. dol., predominantly anhedral, inequigran. cryst. structure. Trace of anhyd. and qtz. inclus.	Poor, irratic rhomb. cleavage. Major large symmet. vugs, infilled with fine to coarse cryst. dol. and anhyd.	▨	▨	▨	As above, but varying greatly in intensity throughout the section - similar interstitial debris.	Coralline structure similar to Stromatoporoidea.	Replacement of apparent large fossil forms with dolomite and anhydrite is paramount. There is also a major fracture pattern.
N-73	-4898	Medium gray and buff-brn. (Predom.)		⊙		Massive, holocryst. dol. and sparse dol.-ls., consisting of equigran. subhedral crystal aggregates. Few crystal growths and inclusions.	Rare, large, symmet. vugs infilled with lt. gray calcite and anhyd.	▨			Slight; calcareous and silty, containing infrequent allogenic clear quartz, and gray-black organic debris.	None	Features of recrystallization are apparent, also, evidence of differential solution in the immediate area of the vugs.
N-75	-4909	Slight med. gray, predom. buff-brown.		⊙		Massive, holocryst. dol. and sparse dol.-ls. as above - slightly more coarse cryst. and more euhedral. Few qtz. inclusions.	Fair rhombohedral cleavage and fracture form. Rare, large, irratic vugs, infilled with anhyd.	▨			Incipient, slightly calcareous and silty matrix with rare anhed. fine cryst. clear quartz inclusions.	Trace of fine, symmetrical fossil shadows.	Tighter crystal aggregates and larger crystals due to recryst. diagenesis. (advanced stage)
N-78	-4923	Slight med. gray, predom. buff.		⊙		As above, tending to be more subhedral. Frequent inclusions of fine and coarse anhed. clear qtz. and gray silt.	Fair rhomb. cleavage. Rare small vugs and blotchy or mottled color changes due to recryst.	▨			Incipient matrix as above, with increased amounts of clear anhed. quartz, gray chert and silt.	Algal remnant showing indistinct shadow of heart and including nuclei.	Authigenic mineral constituents are increased - both inclusively and interstitially - possible concurrent intrus.
N-81	-4938	Med. and dark gray (predom) and buff-brn.		⊙		Massive, merocryst. dol. and dol.ls. consisting of inequigranular anhedral and subhedral crystal aggregates.	Poor rhomb. cleavage - some clouding and mottling due to silt and increased iron (?) content.	▨	▨	▨	Pronounced, calcareous and silty, with considerable allogenic, interstitial inclusions of clear quartz, and organic debris.	None	Authigenic mineral constituents are pronounced as interstitial and matrix inclusions. (rare authigenic feldspar aggregates).
N-83	-4948	As above		⊙		Massive, merocryst. dol. and dol.ls. as above. Frequent inclusions of fine and med. anhed. clear qtz. and gray-black organic debris.	Poor rhomb. cleavage - some clouding and mottling as above.	▨	▨		Matrix is more calcareous and fine to cryptocryst.; copious interstitial inclusions as above.	Altered remnant which is replaced with calcite - shows a slight pseudo-cellular structure.	Authigenic mineral constituents are common as above. Differential solution effects are noticable between matrix and cryst.
N-85	-4957	Med. and dark gray (Predom.) and buff.		⊙		Massive, merocryst. dol. and dol.ls. consisting of inequigran. anhedral and subhed. cryst. aggregates. Common inclusions as above.	Poor rhomb. cleavage. Some mottling and clouding due to increased silt and iron (?) content.	▨	▨	▨	Intermed., very silty, slightly calcareous with considerable interstitial organic debris and trace of quartz.	Symmetrical shadow outline of an Algal remnant showing trace of nuclei.	Considerable rafting of allogenic silts and organic debris. Recrystallization phases are variable.
N-87	-4967	Light gray becoming buff in part.		⊙		Massive, holocryst. dol. becoming predominantly coarse cryst. and subhedral to euhedral. Rare inclus. as above.	Fair rhomb. cleavage. Trace of small vugs infilled with calcite and traces of pyrite.	▨			Slightly calcareous and slightly silty. Trace of fine and coarse cryst. anhed. quartz, interstitial inclusions.	Coralline structure similar to Stromatoporoidea intruded by an indeterminable columnite in section.	Phases of recryst. are well advanced. Traces of differential solution between lt. gray dol. and calc. matrix. Traces of pyrite.
N-89	-4978	Light gray			⊙	Massive, holocryst. dol. and dol.ls. becoming merocryst. in part. Consisting of fine, med. (predom.) and crse. aggregates.	Large symmet. vugs and major dendritic fracture pattern which have been infilled with fine to coarse calcite	▨	▨		Well developed matrix of fine and cryptocryst. ls. (slightly silty) with infrequent quartz and organic inclusions.	None	There is a particularly wide range in crystal size, also, the effects of differential solution are apparent.
N-90	-4981	Light gray becoming buff in part.		⊙		Massive, holocryst. dol. consisting of equigran. subhedral crystal aggregates. Rare zoned crystals and growths.	Due to increased and varying iron (?) content, a slight mottled effect is apparent: fract. pattern.	▨			Matrix as above; slightly more silty in the fracture pattern.	None	Increased silt content of matrix infilling in the fracture pattern indicates post cryst. intrusion.
N-92	-4993	Medium and light gray.			⊙	Massive holocryst. dol. and dol.ls. becoming merocryst. in part. Consisting of inequigran. anhedral and subhedral crystal aggregates.	Major vugs and slight dendritic fracture pattern, infilled with calcite, dol. and green, waxy shale.	▨	▨		Incipient, calcareous, and slightly silty with infrequent interstitial inclusions of light gray silt, clear qtz. and green, waxy shale.	None	Intrusion of green, waxy shale and fine silty limestone into vugs and fracture pattern suggests a marked change in environment.
N-94	-5002	Medium and light gray (Predom.)		⊙		Massive, holocryst. and merocryst. (in part); dol. as above - consisting of crystal aggregates of slightly smaller size. Infrequent inclus.	Rare, small, irregular vugs, infilled with calcite and dolomite and trace of green, waxy shale and pyrite concretions.	▨			As above, with rare inclusions of light gray silt and fine anhed. clear quartz crystals and light gray chert.	Shadowed outline of possible coralline structures which have been highly altered and replaced.	Recrystallized dolomite aggregates, tend to be generally smaller in size.
N-96	-5013	Light gray			⊙	Massive, holocryst. dol. consisting of equigranular subhedral and euhedral crystal aggregates. Trace of crystal growths and zoning.	Fair rhomb. cleavage. Traces of small pyrite nodules disseminated throughout the massive dol.	▨			Slight, incipient, calcareous and silty with rare interstitial inclusions of fine grained, clear quartz.	Rare to indeterminable shadows, which are possibly of organic origin.	Recrystallization becoming advanced, also, common overgrowths are distinguishable.
N-98	-5021	Light gray			⊙	Massive, holocryst. dol. as above, becoming slightly more fine cryst. and more anhed. Trace of zoning and polysynthetic twinning.	Fair rhomb. cleavage and fracture. Rare major symmet. vugs totally infilled with dol. and anhyd.	▨			As above, with traces of fine cryst. pyrite disseminated throughout, also, occasional fragments of organic debris.	Probable coralline structure showing highly distorted cellular structure and wrinkled epithica.	Increased cleavage and fracture forms may indicate increased effects of compaction. Recrystallization is slightly less advanced.
N-99	-5027	Medium and light gray (mottled)			⊙	Massive, holocryst. dol. consisting of predom. coarse equigran. subhedral and euhedral cryst. aggregates. Trace of cryst. growths and zoning.	Fair rhomb. cleavage and fracture. Rare major vugs and fractures are infilled with waxy, green shale and pyrite.	▨	▨		Incipient, calcareous and gray, silty matrix with rare inclusions of fine pyrite and clear quartz.	None	Authigenic, fine and coarse cryst. pyrite and anhydrite is disseminated throughout the dol., green, waxy shale, anhyd. and calcite in vugs.
N-100	-5032	Light gray.			⊙	Massive, holocryst. dol. consisting of fine, med. (predom.) and coarse anhedral to euhedral crystal aggregates. Trace of cryst. growths.	Fair rhomb. cleavage. Variations in silt and iron (?) content produce a slightly mottled effect.	▨			As above, with varying amounts of silt and iron (?) content. Few interstitial inclusions of qtz. and organic debris.	Apparent remnant structure of Bryozoa.	Wide range in phases of recryst. and also in amount of matrix material and degrees of differential solution.
N-101	-5038	Light gray			⊙	Massive, holocryst. dol. as above. Trace of crystal growths; polysynthetic twin lamellas and zoned dol. crystals.	Fair rhomb. cleavage in coarser crystals. Rare, large, symmet. vugs infilled with dol. calcite and anhyd.	▨			Varying, incipient, calcareous and sl. silty with increased amounts of interstitial quartz and organic debris.	Distorted structure similar to Bryozoa- outlining zoaria segment and zooecial openings.	Authigenic replacement in the large vugs has resulted in textures which outline apparent fossil remnants
N-102	-5043	Medium and light gray (mottled).		⊙		Massive, holocryst. and merocryst., inequigranular fine and med. cryst. dol. and dol.-ls. The crystalline aggregates are quite variable.	Poor rhomb. cleavage and fracture. Common large, symmet. vugs infilled with dol. ls. (altered fossil remnants).	▨	▨		Light gray, highly calcareous and silty matrix with inclusions of clear anhed. quartz; traces of organic debris.	Quite distinct outline of algal units.	Predom. med. to fine dol. cryst. aggregates, plus marked differential solution effects; point to an incomplete stage of dolomitization.
N-103	-5048	Medium and light gray (mottled).		⊙		Massive, holocryst. and merocryst., inequigran. dol. and dol. ls. predom. anhedral and fine to med. cryst. Rare qtz. inclus.	Poor rhomb. cleavage and fracture. Common large symmet. vugs infilled with dol. ls. (altered fossil remnants).	▨	▨		As above; tending to be more crypto-cryst.	Algal units as above with good remnants of nuclei.	Incomplete stage of dolomitization as above; possible reason for more distinct fossil remnants.
AMERADA CROWN "C"													

AND CLAIRMONT REEF COMPLEXES:

CHEMICAL COMPOSITION:

	REMARKS: PARTICULAR DIAGENIC EFFECTS
	Recrystallization and the effects of compaction are apparent but not excessively so.
-	Replacement of large fossil forms by calcite and minor authigenic pyrite and anhydrite is particularly predominant.
l-	Matrix cement is sparse and contains less authigenic organic debris. A few growth crystals can be observed.
d	Effects of compaction are not as noticeable while matrix cement containing authigenic organic debris, and quartz is additive.
-	Replacement of apparent large fossil forms with dolomite and anhydrite is paramount. There is also a major fracture pattern.
	Features of recrystallization are apparent, also, evidence of differential solution in the immediate area of the vugs.
	Tighter crystal aggregates and larger crystals due to recryst. diagenesis. (advanced stage)
dow	Authigenic mineral constituents are increased - both inclusively and interstitially - possible concurrent intrus.
	Authigenic mineral constituents are pronounced as interstitial and matrix inclusions. (rare authigenic feldspar aggregates).
h lar	Authigenic mineral constituents are common as above. Differential solution effects are noticable between matrix and cryst.
l	Considerable rafting of allogenic silts and organic debris. Recrystallization phases are variable.
e- e	Phases of recryst. are well advanced. Traces of differential solution between lt.gray dol. and calc. matrix. Traces of pyrite.
	There is a particularly wide range in crystal size, also, the effects of differential solution are apparent.
	Increased silt content of matrix infilling in the fracture pattern indicates post cryst. intrusion.
	Intrusion of green, waxy shale and fine silty limestone into vugs and fracture pattern suggests a marked change in environment.
ne .	Recrystallized dolomite aggregates, tend to be generally smaller in size.
n	Recrystallization becoming advanced, also, common overgrowths are distinguishable.
nd	Increased cleavage and fracture forms may indicate increased effects of compaction. Recrystallization is slightly less advanced.
	Authigenic, fine and coarse cryst. pyrite and anhydrite is disseminated throughout the dol., green, waxy shale, anhyd. and calcite in vugs.
e.	Wide range in phases of recryst. and also in amount of matrix material and degrees of differential solution.
ca- l	Authigenic replacement in the large vugs has resulted in textures which outline apparent fossil remnants
ts.	Predom. med. to fine dol. cryst. aggregates, plus marked differential solution effects; point to an incomplete stage of dolomitization.
ants	Incomplete stage of dolomitization as above; possible reason for more distinct fossil remnants.



			aggregates are quite variable.	nants).		
N-103	-5048	Medium and light gray (mottled).	Massive, holocryst. and merocryst., inequigran. dol. and dol. ls. predom. anhedral and fine to med. cryst. Rare qtz. inclus.	Poor rhomb. cleavage and fracture. Common large symmet. vugs infilled with dol. ls. (altered fossil remnants).	As above; tending to be more crypto-cryst.	Algal units as above with good remnants of nuclei.	Incomplete stage of dolomitization as above; possible reason for more distinct fossil remnants.

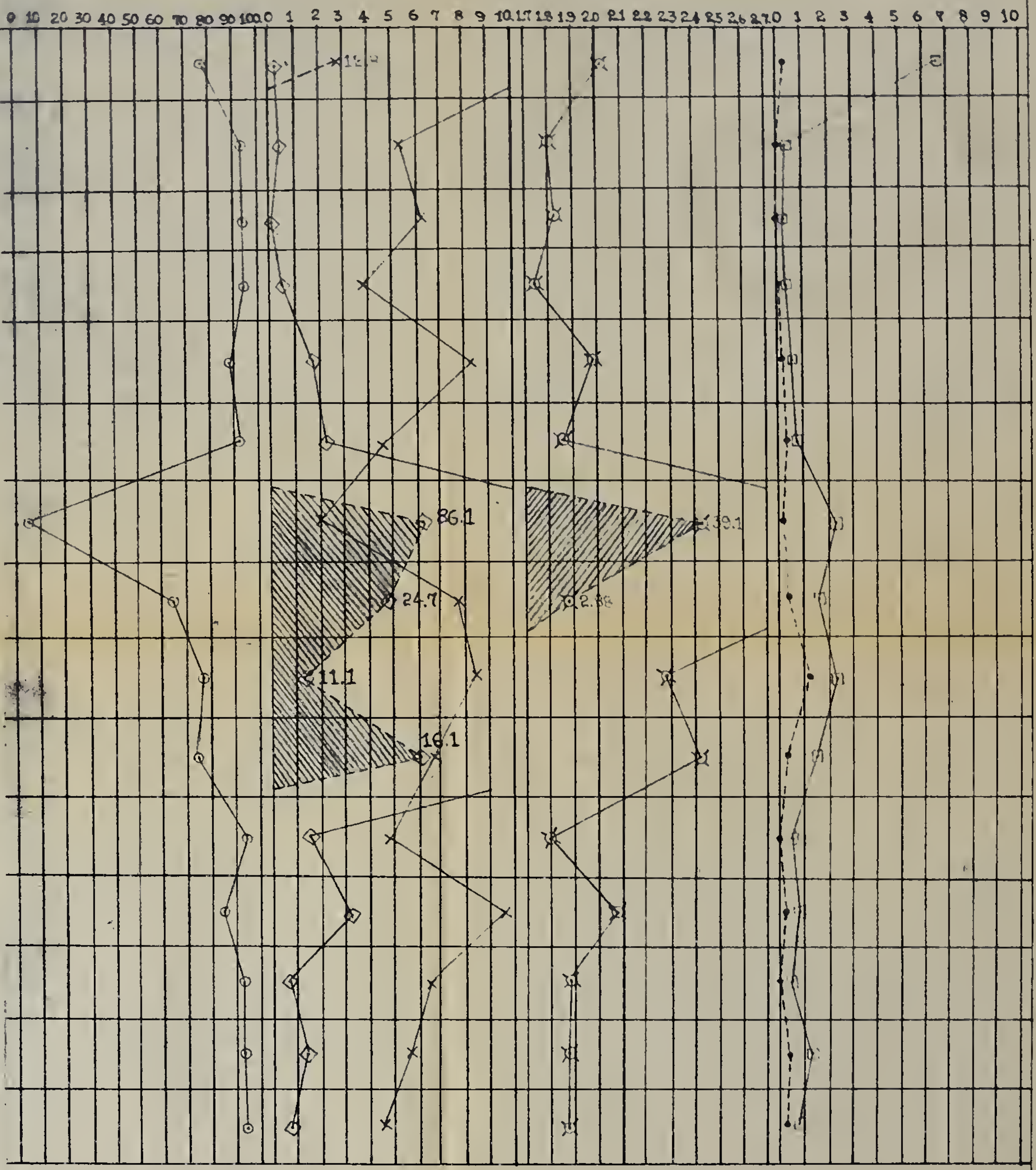
AMERADA CROWN "O"
F33-32

0 - 1	-6268	Med. gray grading to light gray.	Massive, merocryst. silty dol. and dol. ls. consisting of equigran. fine anhedral crystal aggregates and fine silt (clouding aggregates).	Trace of rhomb. cleavage and fract. Some shading in the silt but no discernible bedding.	Highly silty and slightly calcareous matrix. Rare interstitial inclusions of clear, fine, anhed. qtz. and organic debris.	Small Gastropoda structurally altered and replaced by crystalline calcite and dolomite.	Very silty matrix which diffuses into and clouds the slightly recryst. fine dol. and dol.-ls.
0 - 3	-6273	Light gray and cream buff.	Massive holocryst. dol. consisting of equigranular, med. and coarse, subhedral crystal aggregates. Common inclusions of fine and medium clear qtz., anhyd.; trace tourmaline.	Good rhomb. cleavage; poor fract. Few small, irratic vugs, infilled with coarse euhedral calcite and anhyd.	Incipient, med. gray, silty and slightly calcareous matrix with common interstitial inclusions of quartz and organic debris.	None	Recryst. has reached an advanced stage. The preponderance of inclusions is worthy of particular note.
0 - 5	-6277	Cream buff (predom.) and light gray.	Massive, holocryst. dol. as above, becoming more coarse cryst. and more euhedral. Fewer inclusions.	Good rhomb. cleavage; poor fract. Rare small vugs infilled as above.	Incipient, med. gray, silty and sl. calcareous matrix. Rare interstitial inclusions, as above.	None	Very tight, coarse cryst. mozaic showing effects of compaction and advanced phase of recryst.
0 - 7	-6283	As above	Massive, holocryst. dol., coarse and tending to euhed. as above. Common crystal growths; common inclusions - mostly anhydrite.	Good rhomb. cleavage; poor fract. incipient dendritic fracture pattern infilled with anhyd.	Matrix as above. Interstitial material consists of clear qtz., organic debris and (predom.) anhyd. crystals.	Skeletal outline of possible Bryozoan showing zooecial openings and dendroidal structures.	Differential solution is slight, fine silt content clouds the aggregate.
0 - 9	-6290	Cream buff with light and dark gray mottling	As above. Common crystal growths; varying amounts of silt and iron has produced a faint mottled effect. Rare inclusions as above.	Fair rhomb. cleavage; poor fract. Trace of disseminated pyrite.	Matrix as above. Common interstitial inclusions of fine and medium subhedral cryst. of anhydrite.	Symmetrical outline of Algae, showing shadows of heart and nuclei.	Persistently good rhomb. cleavage cracks, infilled in part with fine silt and anhydrite.
0 - 10	-6298	Cream buff and minor light gray	Massive, holocryst. dol. consisting of equigran. med. and coarse, subhedral and euhedral crystal aggregates. Frequent anhyd. inclusions.	Good rhomb. cleavage; faint dendritic fract. pattern infilled with anhyd. and trace of calcite.	Matrix becoming very incipient. Rare interstitial inclusions of anhydrite, clear quartz and organic debris.	Few small symmetrical vugs; infilled with crystalline calcite, anhydrite and dolomite.	Anhydrite infilling and inclusions remain a consistent feature.
0 - 11	-6303	Light gray - white.	Massive, merocryst. anhydrite, consisting of inequigran., crypto. to coarse, anhedral to euhedral, cryst. aggregates. Occasional clear quartz inclusions.	Good parallel cleavage; poor fract. Anhydrite has a fibrous texture in part; varies to cryptocrystalline.	Matrix of cryptocryst. and fine anhyd. with traces of light gray silt becoming more prominent.	Some fibrous, directional crystal forms - no distinct fossil remnants.	Anhydrite texture varies from cryptocryst. to coarse cryst. and fibrous. Few inclusions of fine and med. anhed. clear quartz crystals.
0 - 12	-6309	Dark and light gray (mottling)	Holocryst. dol. and merocryst. anhyd. as above. Frequent inclusions of anhyd. and fine, anhed. clear qtz. in the dol. phase.	Fair parallel cleavage in the anhyd. and rhomb. cleavage in the dol. aggregates.	Matrix is essentially cryptocryst. and fine anhyd., and faint, light gray silt and silty limestone.	Crystalline remains of crinoid calyx and columnal.	Slight effects of differential solution are apparent between the anhydrite and dolomite. (Mostly anhyd. infilling).
0 - 14	-6314	As above; more light gray.	Holocryst. dol. as above, becoming more coarse cryst. and more euhed. Common crystal growths. Rare clear quartz and anhyd. inclusions.	Good rhomb. cleavage and fracture, infilled with cryptocryst. to coarse euhed. anhydrite.	Incipient, med. gray, silty and slightly calcareous matrix, containing varying amounts of interstitial anhydrite.	None	Crystal growths and rhomb. cleavage reflect a more advanced stage of recryst. and subsequent effects of compaction.
0 - 16	-6319	As above; more dark gray.	Holocryst. dol. and dol.-ls.; coarse cryst. as above, and merocryst. anhyd. as above. Common crystal growths.	Good rhomb. cleavage and fracture, infilled with anhyd. as above. Trace of disseminated pyrite.	Matrix as above, with varying amounts of interstitial silt and iron (?). More calcareous.	Indeterminable fossil remnant - similar to a tabulate coral structure.	Varying amounts of included and interstitial silt and iron (?) have produced a faint mottling in the dolomite.
0 - 20	-6325	Light gray and cream buff.	Massive, holocryst. dol. consisting of equigran., med. to coarse, subhedral and euhedral crystal aggregates. Rare inclusions.	Good rhomb. cleavage and fracture, infilled in part with fine, medium gray silt. Rare, small, irratic vugs.	Incipient matrix of slightly calcareous fine, medium gray silt. Rare interstitial inclusions of clear quartz and organic debris.	Few faint, symmetrical shadows which are indeterminable.	Crystal growths are frequent; large crystal aggregates which are clouded with medium gray silt.
0 - 22	-6333	As above; med. gray mottling in part.	Massive, holocryst. dol. as above. Common crystal growths. Occasional inclus. of fine anhed. qtz. and opaque, organic debris.	Cleavage and fracture as above - similarly infilled. Rare, small, irratic vugs, infilled with coarse calcite (crystalline).	Silty and slightly calcareous matrix as above. Rare interstitial inclusions as above.	Coralline structure: - remnants of laminae and radial pillars.	Crystal aggregates similar to above and similarly clouded with silt.
0 - 24	-6339	As above.	Massive, holocryst. dol. as above. Common crystal growths. Rare inclusions as above. Trace of zoning.	Fair rhomb. cleavage and fracture, infilled in part, as above. Rare, large vugs, infilled with coarse euhedral calcite (crystalline).	Silty and slightly calcareous matrix as above. Rare interstitial inclusions as above.	None	Advanced stage of recryst. as above; less clouding of crystal aggregates due to silt and iron (?) content.
0 - 26	-6344	Light and dark gray, cream buff in part.	Massive, holocryst. dol. consisting of equigranular, subhedral and euhedral, predominantly coarse crystal aggregates. Rare crystal growths.	Good rhomb. cleavage; poor fracture, infilled in part with dark gray silt and fine cryst. anhydrite.	Incipient matrix of slightly calcareous, medium and dark gray silt. Common interstitial inclusions of anhydrite; traces of quartz.	Crystalline and shadowed outline of Algae showing shadow of internal structure.	Recryst. features as above. Interstitial silt has become darker. Occasional small pyrite concretions.
0 - 27	-6348	As above; more cream buff.	Massive holocryst. dol. as above. Common crystal growths. Trace of inclusions of fine and medium anhed. and subhed. qtz. and organic debris.	Good rhomb. cleavage; poor fracture. Few major vugs infilled with coarse euhedral dol. and anhed. calcite.	Matrix as above. Interstitial inclusions as above. Trace of authigenic organic debris.	Rare, large, symmetrical vugs, indeterminable remnants.	Recryst. features as above. Variations in included silt and iron (?) content have produced a faint mottling.

A.P.C.-H.R.-UNION
CROWN "Y" 2-11

Y - 1	-6201	Cream-buff and minor light gray.	Massive, holocryst. dol. consisting of coarse, equigranular, euhedral and subhedral crystal aggregates. Frequent crystal growths.	Fair to good rhomb. cleavage and fracture. Common, small vugs and dendritic fract. patterns (sec. infilling).	Matrix consists of slightly calcareous, medium gray, fine silt which diffuses into and clouds the aggregate.	Structural remnants of a lobe of Stromatopora, showing fragments of epithica and columnar structure.	Common cryst. growths and predominantly coarse, subhed. and euhed. crystallization indicates advanced stage of recryst. phase.
Y - 2	-6203	Cream-buff, med. gray in diffused pattern.	As above, becoming medium and fine anhedral, in darker diffused ankerite phase; fracture pattern. Trace of polysynthetic twinning.	Good rhomb. cleavage. Rare, small, irratic vugs and dominant fracture pattern, infilled with buff dol. and calcite.	Matrix more pronounced, consisting of calcareous, light and dark gray silt with varying iron (?) content, plus fine pyrite.	Indeterminable shadowed, symmetrical outline with apparent nuclear inclusions.	There is considerable fine, disseminated pyrite in matrix and as inclusions in the coarse dol. crystals (authigenic).
Y - 3	-6205	Light gray and cream buff.	As above with varying amounts of iron (?) and minor silt, producing a mottling effect. Rare inclusions of fine anhedral, clear quartz and pyrite	Fair rhomb. cleavage and fracture. Rare small vugs, infilled with coarse euhedral, light gray calcite and buff dol.	Matrix as above, also containing rare, fine, anhedral crystals of clear and frosted quartz.	None	The persistent, fair and good rhomb. cleavage and fracture, and tight cryst. aggregates, directly reflect compaction effects.
Y - 4	-6207	As above.	Massive, holocryst. dol. consisting of coarse, euhedral and subhedral, equigranular crystal aggregates. Common crystal growths.	Fair rhomb. cleavage and fracture. Rare, small, irratic vugs infilled with light gray calcite, buff dol. and pyrite.	Matrix contains less silt; diffuses into the crystal aggregates; considerable authigenic disseminated pyrite.	Coralline structures showing tabulae and pillars which have been replaced by pyrite.	Authigenic minerals (pyrite, calcite and traces of anhydrite) are common - also, effects of differential solution.
Y - 5	-6210	Lt. gray, becoming more cream buff.	As above. Common crystal growths. Traces of polysynthetic twin lamellae and zoning.	Fair rhomb. cleavage and major dendritic fracture pattern infilled with calcite, anhyd. and bit.	Calcareous and silty matrix is more prominent, also fine, anhed. clear qtz. Interstitial inclus. more frequent.	Rare, small, symmetrical vugs - no fossil traces.	There are persistent but sparse inclusions of fine, gray, organic debris and silt in the interstit. spaces & dol. cryst.
Y - 6	-6212	As above.	Massive, holocryst. dol. tending to become merocryst. and medium in cryst. size in some sectors.	Poor rhomb. cleavage. Extensive fracturing where dendritic fract. pattern is infilled with calcite, silt and bit.	Matrix as above, is more extensive particularly in the immediate locale of the fracture pattern.	Orbicular and cellular fossil forms which are distinguishable as faint shadows.	Sec. fract. and subsequent infilling with calc., fine gray silt and fine org. debris and clear quartz (diffuse into the dolomite.)
Y - 7	-6214	Light gray and cream buff.	Massive, holocryst. dol. consisting of coarse subhedral and euhedral, equigran. crystal aggregates. Common crystal growths.	Fair rhomb. cleavage and fracture. Rare, small, irratic vugs, infilled with coarse euhedral dol. and calcite crystals.	Slight, incipient matrix of slightly calcareous, gray silt which diffuses, in part, into the dolomite.	Probable remnants of an umbilicate Gastropoda showing body whorls and spire.	Effects of compaction are noticeable; crystal aggregates form a very tight mozaic.
Y - 8	-6217	Light gray and cream buff.	Massive, holocryst. and merocryst. dol. and dol.-ls., consisting of fine, med. (predom.) and coarse anhed. and subhed. crystal aggregates.	Poor rhomb. cleavage and fracture. Considerable disseminated light gray silt which clouds mozaic.	Well defined matrix of calcareous, fine, light gray silt and cryptocryst. L.S. Few clear quartz and organic inclusions.	Trace of crystalline material with a fibrous structure.	Recryst. is less complete; differential solution and diffusion between dolomite crystals and matrix is quite apparent.
Y - 9	-6221	As above, be-	As above. Trace of crystal growths.	Cleavage and fracture as above.	As above, with varying amounts of in-	None	Interstitial and included silt content

Incomplete stage of dolomitization as above; possible reason for more distinct fossil remnants.



Very silty matrix which diffuses into and clouds the slightly recryst. fine dol. and dol.-ls.

Recryst. has reached an advanced stage. The preponderance of inclusions is worthy of particular note.

Very tight, coarse cryst. mozaic showing effects of compaction and advanced phase of recryst.

Differential solution is slight, fine silt content clouds the aggregate.

Persistently good rhomb. cleavage cracks, infilled in part with fine silt and anhydrite.

Anhydrite infilling and inclusions remain a consistent feature.

Anhydrite texture varies from crypto-cryst. to coarse cryst. and fibrous. Few inclusions of fine and med. anhed. clear quartz crystals.

Slight effects of differential solution are apparent between the anhydrite and dolomite. (Mostly anhyd. infilling).

Crystal growths and rhomb. cleavage reflect a more advanced stage of recryst. and subsequent effects of compaction.

Varying amounts of included and interstitial silt and iron (?) have produced a faint mottling in the dolomite.

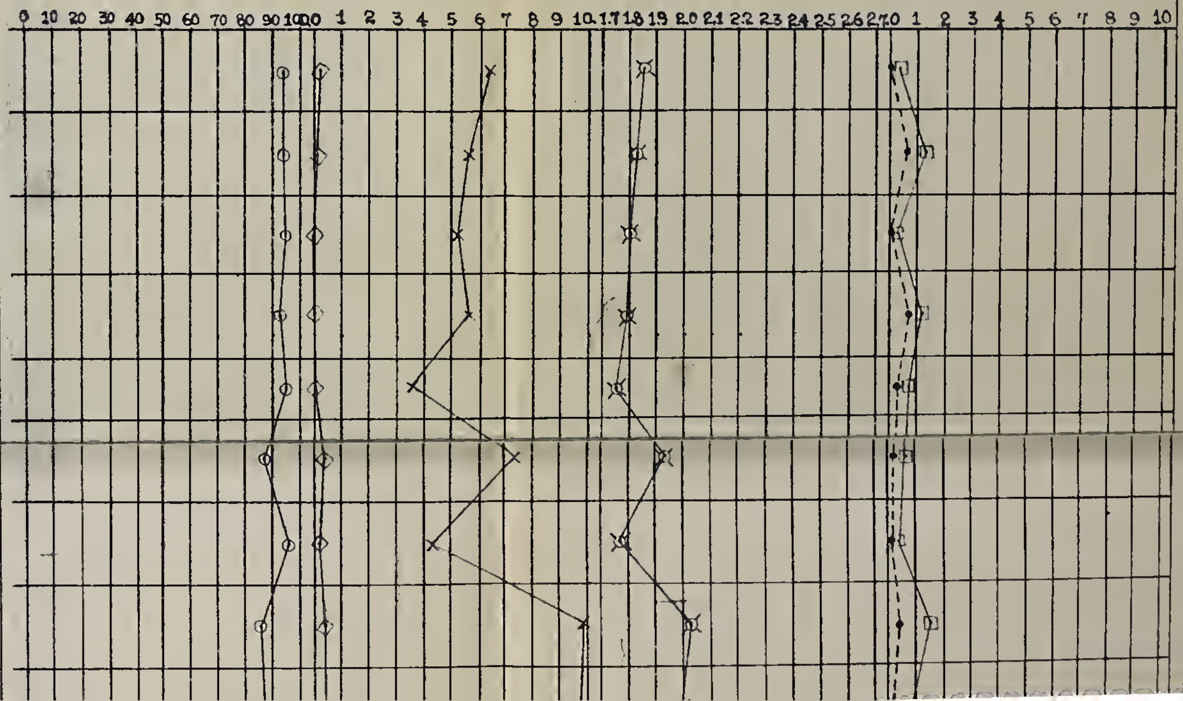
Crystal growths are frequent; large crystal aggregates which are clouded with medium gray silt.

Crystal aggregates similar to above and similarly clouded with silt.

Advanced stage of recryst. as above; less clouding of crystal aggregates due to silt and iron (?) content.

Recryst. features as above. Interstitial silt has become darker. Occasional small pyrite concretions.

Recryst. features as above. Variations in included silt and iron (?) content have produced a faint mottling.



Common cryst. growths and predominantly coarse, subhed. and euhed. crystallization indicates advanced stage of recryst. phase.

There is considerable fine, disseminated pyrite in matrix and as inclusions in the coarse dol. crystals (authigenic).

The persistent, fair and good rhomb. cleavage and fracture, and tight cryst. aggregates, directly reflect compaction effects.

Authigenic minerals (pyrite, calcite and traces of anhydrite) are common - also, effects of differential solution.

There are persistent but sparse inclusions of fine, gray, organic debris and silt in the interstit. spaces & dol. cryst.

Sec. cryst. and subsequent infilling with calc., fine, gray silt and fine org. debris and clear quartz (diffuse into the dolomite.)

Effects of compaction are noticeable; crystal aggregates form a very tight mozaic.

Recryst. is less complete; differential solution and diffusion between dolomite crystals and matrix is quite apparent.

Interstitial and included silt content

Y - 6	-6212	As above.	Massive, holocryst. dol. tending to become merocryst. and medium in cryst. size in some sectors.	Poor rhomb. cleavage. Extensive fracturing whose dendritic fract. pattern is infilled with calcite, silt and bit.	Matrix as above, is more extensive particularly in the immediate locale of the fracture pattern.	Orbicular and cellular fossil forms which are distinguishable as faint shadows.	Sec. fract. and subsequent infilling with calc., fine, gray silt and fine org. debris and clear quartz (diffuse into the dolomite.)
Y - 7	-6214	Light gray and cream buff.	Massive, holocryst. dol. consisting of coarse subhedral and euhedral, equigran. crystal aggregates. Common crystal growths.	Fair rhomb. cleavage and fracture. Rare, small, irratic vugs, infilled with coarse euhedral dol. and calcite crystals.	Slight, incipient matrix of slightly calcareous, gray silt which diffuses, in part, into the dolomite.	Probable remnants of an umbilicate Gastropoda showing body whorls and spire.	Effects of compaction are noticeable; crystal aggregates form a very tight mozaic.
Y - 8	-6217	Light grey and cream buff.	Massive, holocryst. and merocryst. dol. and dol.-ls., consisting of fine, med. (predom.) and coarse anhed. and subhed. crystal aggregates.	Poor rhomb. cleavage and fracture. Considerable disseminated light gray silt which clouds mozaic.	Well defined matrix of calcareous, fine, light gray silt and cryptocryst. L.S. Few clear quartz and organic inclusions.	Trace of crystalline material with a fibrous structure.	Recryst. is less complete; differential solution and diffusion between dolomite crystals and matrix is quite apparent.
Y - 9	-6221	As above, becoming more light gray.	As above. Trace of crystal growths. Trace of polysynthetic twinning and lamellae, clear anhed. qtz. and garnet inclusions.	Cleavage and fracture as above. Slight mottled effect due to silt and iron (?) content.	As above, with varying amounts of included fine, anhed. cryst. of clear qtz. and dark gray organic debris.	None	Interstitial and included silt content is relatively higher; also, more common quartz and organic debris.
Y - 10	-6224	Light gray, slightly buff.	As above; becoming more coarse, cryst. and more subhedral. There is less silt included in the dol. cryst. aggregatse.	Fair rhomb. cleavage. Trace of fracturing. Rare, small, irratic vugs, infilled with coarse calcite and dol.	Matrix consists of calcareous, fine, light gray silt and fine, cryptocryst. dol.-ls.	Few small symmetrical vugs infilled with calcite and anhydrite.	Crystalline texture is more coarse; silty constituents as inclusions and in interstitial spaces are more rare.
Y - 11	-6228	Light and medium gray and cream-buff in part.	Massive, holocryst. dol. and merocryst. dol.-ls., consisting of inequigran., fine to coarse, anhedral to subhedral crystal aggregates.	Fair rhomb. cleavage and dendritic fracturing pattern, infilled with dol. calcite and crypto. ls.	Matrix of calcareous, light gray silt and cryptocryst. ls. varies - increasing in the dol. ls. phase.	Algal remnants partially replaced by pyrite.	Crystal size and texture varies from fine, cryptocryst. in the dol.-ls. phase to coarse, euhedral in the dol. phase.
Y - 12	-6232	As above, more light gray.	As above, tending to be more coarse, cryst. more equigranular and more subhedral. Rare crystal growths, zoned crystals and twin lamellae.	Fair rhomb. cleavage and fracture. Mottled in part due to increased iron (?) content.	Matrix as above. Few inclusions of fine, anhed., clear and frosted quartz crystals and organic debris.	None	Extending into the dolomite phase, there is an increase in the amount of authigenic pyrite (disseminated and nodules), calcite and anhydrite.
Y - 13	-6241	Cream-buff and minor light gray.	Massive, holocryst. dol. consisting of med. and coarse equigran. euhed. and subhed. crystal aggregates. Trace of garnet inclusions.	Good rhomb. cleavage and fracture. Common small vugs, infilled with coarse euhed. dol., calcite and anhydrite.	Incipient, calcareous and silty matrix cryptocryst. ls. in part; sparse interstitial inclusions.	Apparent fossil shadows of a tabular and cellular structure.	Advanced recryst. is apparent; differential solution and diffusion is at a minimum.
Y - 14	-6247	Medium and light gray.	Merocryst. and holocryst., anhed. and subhed., fine to coarse cryst. dol. and dol.-ls. infused with crypto. to coarse cryst. ls. and anhyd.	Major fracture pattern, infilled with crypto. to coarse cryst. ls. and anhyd.	Pronounced matrix of silty, crypto-cryst. ls. and fine to coarse cryst. anhydrite; traces of pyrite.	Corallum structure which is similar to Plasmopora (a colonial coral).	The structures and textures present an outline of apparent alteration and replacement structures of large fossil units.
Y - 15	-6252	As above.	As above; dol. and dol.-ls. textures and structures tend to be more med. cryst., inequigran. and more anhed.	Major vugs and fracture pattern infilled with ls. and anhyd. as above, with traces of pyrite and bit.	Matrix as above - diffuses into the dolomite and dol.-ls. phases.	Trace of fibrous and cellular fossil units replaced by anhyd.	As above; authigenic replacement of fossil units by limestone, calcite, and anhydrite . Bitumen is prevelent.
Y - 16	-6259	Cream-buff	Massive, holocryst. dol. consisting of med. and coarse, equigranular, subhedral and anhedral crystal aggregatse.	Fair rhomb. cleavage and fracture. Rare small, irratic vugs, infilled with calcite.	Matrix consists of slightly calc. medium gray, fine silt, which diffuses in part into the dol. aggreg.	None	Evident changes in cryst. texture due to growth of small crystals into a coarser crystal aggregate.
Y - 17	-6263	Cream-buff	As above, becoming more euhedral and more coarse cryst. Frequent crystal growths. Trace of twinning and zoning.	Good rhomb. cleavage and fracture. Common pyrite concretions.	Matrix as above. Slight, variable amounts of iron (?) have produced an incipient, mottled effect.	None	Crystal growths are prevalent. There are common inclusions of fine, anhed. clear and frosted quartz, and traces of organic debris.
Y - 18	-6266	Medium and light gray to cream - buff.	Holocryst. and merocryst. dol. and dol. ls. consisting of inequigran. fine, anhed. to coarse, subhed. and euhed. cryst. aggregatse.	Poor rhomb. cleavage; major dendritic fracture pattern (altered and replaced fossil struct.)	Matrix varies from fine, silty, crypto. ls. to coarser anhed. crystals of anhydrite and calcite.	A similar corallum structure to Halysites.	Structures and textures outline an apparent alteration and replacement of major fossil units.
Y - 19	-6272	Light gray and cream-buff.	Massive, holocryst. dol. consisting of equigran., subhedral and euhedral, coarse crystal aggregates. Common crystal growths.	Good rhomb. cleavage. Rare, small, irratic vugs, infilled with coarse, euhed. calcite cryst.	Incipient, slightly calcareous and silty matrix with rare interstitial inclusions of fine, clear quartz and organic debris.	None	Intimacy of crystal mozaics and aggregates reflects the effects of differential compaction.
Y - 20	-6280	Light gray white and cream-buff.	cryptocryst., merocryst. and holocryst. anhydrite, dol. and dol.-ls. Diffused in immediate contacts.	Major fracture, alteration and replacement patterns. Rare, small vugs infilled with anhyd.	Matrix is variable in extent and constituents; from incipient, fine, calc. silt to predom. coarse, cryst. anhyd.	Few indistinct shadows.	Differential solution effects are predominant in the replacement and infilling of major dol. struct. with anhyd.
Y - 22	-6317	Cream-buff and light gray.	Massive, holocryst. dol. consisting of med. and coarse, equigran., subhedral crystal aggregates. Frequent crystal growths.	Fair rhomb. cleavage and fracture pattern; rare large vugs infilled with calcite and anhyd.	Incipient, slightly calcareous and silty matrix which diffuses in part into the dolomite cryst. aggregate.	None	Crystal growths are frequent; recryst. has reached an advanced stage. Authigenic minerals include calcite, anhydrite and fine pyrite.
Y - 23	-6321	Medium and light gray - buff cream in part.	Holocryst. and merocryst. dol. and dol.-ls., consisting of fine anhed. to predominantly med. and coarse subhed. and euhed. crystal aggregates.	Fair rhomb. cleavage; major fract. pattern and large, symmet. vugs have been infilled with calcite.	Variable matrix consists of silty, cryptocryst. and fine cryst. ls. with rare interstitial inclusions of qtz.	Coralline structure with reticulate pattern - similar to vertical section of Stromatopora.	Increased iron (?) content has resulted in a slightly mottled effect. Differential solution effects are apparent.
Y - 24	-6331	As above; more dark gray.	Massive, merocryst. dol. and dol.-ls. consisting of fine, anhed. and coarse subhed. crystal aggregates. Common inclusions of qtz. and organic debris.	Poor rhomb. cleavage and fracture. Material is dense with no vugs and poor visual porosity.	Matrix as above with more frequent interstitial inclusions of fine, anhed. clear quartz and organic debris.	Trace of indeterminable fossil shadows.	Alteration and recryst. phase of ls. to dol. is emphasized; allogenic inclusions of fine, clear, anhed. qtz. (and trace of garnet) are rare.
Y - 25	-6335	Medium and light gray, cream - buff in part.	Massive, holocryst. dol. and dol.-ls. consisting of med. (predom.) and coarse anhed. and subhed. crystal aggregates.	Poor to fair rhomb. cleavage. Some mottling due to varying content of iron (?), no silt.	Matrix consists of slightly silty cryptocryst. and fine cryst. Ls. with interstitial inclusions of clear qtz.	None	Similar effects as above are observed. Color variations and mottling are prevalent.
Y - 26	-6340	As above.	As above. There are frequent cryst. growths and occasional inclusions of fine anhed. clear qtz. (Trace of garnet).	Fair rhomb. cleavage; slight dendritic fracture pattern and rare vugs infilled with coarse calcite (crystalline).	Matrix as above, more cryptocryst.	Rare small, symmetrical vugs, infilled with coarse, crystalline calcite.	Similar to above. Crystal growths can be observed in different stages of recrystallization.
Y - 27	-6352	Medium and light gray - cream-buff.	Massive, holocryst. dol. consisting of medium (predom.) and coarse anhedral and subhedral, crystal aggregates. Common crystal growths.	Fair rhomb. cleavage; slight dendritic fracture; rare large vugs infilled with coarse calcite.	Incipient, light gray, silty and cryptocryst. dolomitic ls. matrix. Sparse, clear quartz and organic debris, interstitial inclusions.	Structure similar to Bryozoa showing zoaria and zooecial opening.	Extensive crystal growths indicate a more advanced stage of recrystallization. Differential solution is slight.
Y - 28	-6356	As above; becoming more medium gray.	Massive, holocryst. dol. (merocryst. in part), consisting of equigran. medium (predom.) and coarse, anhed. and subhed., crystal aggregates.	Fair rhomb. cleavage; major dendritic fracture pattern; few small vugs infilled with coarse calcite and anhydrite.	Matrix of highly silty, fine and cryptocryst. ls. is more pronounced.	Faint, indeterminable fossil shadows.	Allogenic silt is prominent as both interstitial and crystal inclusions also increase in included quartz and organic debris.

IMPERIAL CLAIRMONT
#1

C - 8	-8264	Medium and dark gray.	Massive, merocryst. dol. and dol.-ls. consisting of equigran., med. (predom.) and coarse subhed. crystal aggregates	Fair rhomb. cleavage; slight fract. There is a fine, rude bedding due to variations in silt content, and texture.	There is a pronounced matrix of dark gray, calcareous silt and silty ls.; also common qtz., opaques, and organic debris contained as interstit. mat.	Algal unit which has been altered and replaced by calcite and pyrite.	Rude bedding and varved appearance may indicate lagoonal conditions; lacks textures and structures of reefoid complexes.
C - 8A	-8265	Medium and dark gray.	Massive, merocryst. dol. and dol.-ls. becoming more inequigran. and grading to fine cryst. in part.	Poor rhomb. cleavage and fracture. Rude bedding as above. Trace of pyrite concretions.	As above, less silty, more crypto-cryst. and fine cryst. ls. plus interstitial inclusions.	None	Although the effects of compaction are apparent in the origin of the bedding, tight, recryst. text. gen. absent.
C - 9	-8267	Medium and dark gray (predom.)	As above; tending to be more anhed. and med. in cryst. size. Common crystal growths. Trace of polysynth. twin lamellae.	Fair rhomb. cleavage; slight fract. Rude bedding as above; mottled pattern, perpendicular to bedding.	As above, becoming more silty with similar interstitial material. (Allogenic and authigenic.)	A small pseudo-cellular structure - no determinable remnants.	Although matrix is well developed, differential solution effects in the dolomite aggregates are only slight.

Sec. frast. and subsequent infilling with calc., fine, gray silt and fine org. debris and clear quartz (diffuse into the dolomite.)

Effects of compaction are noticeable; crystal aggregates form a very tight mozaic.

Recryst. is less complete; differential solution and diffusion between dolomite crystals and matrix is quite apparent.

Interstitial and included silt content is relatively higher; also, more common quartz and organic debris.

Crystalline texture is more coarse; silty constituents as inclusions and in interstitial spaces are more rare.

Crystal size and texture varies from fine, cryptocryst. in the dol.-ls. phase to coarse, euhedral in the dol. phase.

Extending into the dolomite phase, there is an increase in the amount of authigenic pyrite (disseminated and nodules), calcite and anhydrite.

Advanced recryst. is apparent; differential solution and diffusion is at a minimum.

The structures and textures present an outline of apparent alteration and replacement structures of large fossil units.

As above; authigenic replacement of fossil units by limestone, calcite, and anhydrite . Bitumen is prevalent.

Evident changes in cryst. texture due to growth of small crystals into a coarser crystal aggregate.

Crystal growths are prevalent. There are common inclusions of fine, anhed. clear and frosted quartz, and traces of organic debris.

Structures and textures outline an apparent alteration and replacement of major fossil units.

Intimacy of crystal mozaics and aggregates reflects the effects of differential compaction.

Differential solution effects are predominant in the replacement and infilling of major dol. struct. with anhyd.

Crystal growths are frequent; recryst. has reached an advanced stage. Authigenic minerals include calcite, anhydrite and fine pyrite.

Increased iron (?) content has resulted in a slightly mottled effect. Differential solution effects are apparent.

Alteration and recryst. phase of ls. to dol. is emphasized; allogenic inclusions of fine, clear, anhed. qtz. (and trace of garnet) are rare.

Similar effects as above are observed. Color variations and mottling are prevalent.

Similar to above. Crystal growths can be observed in different stages of recrystallization.

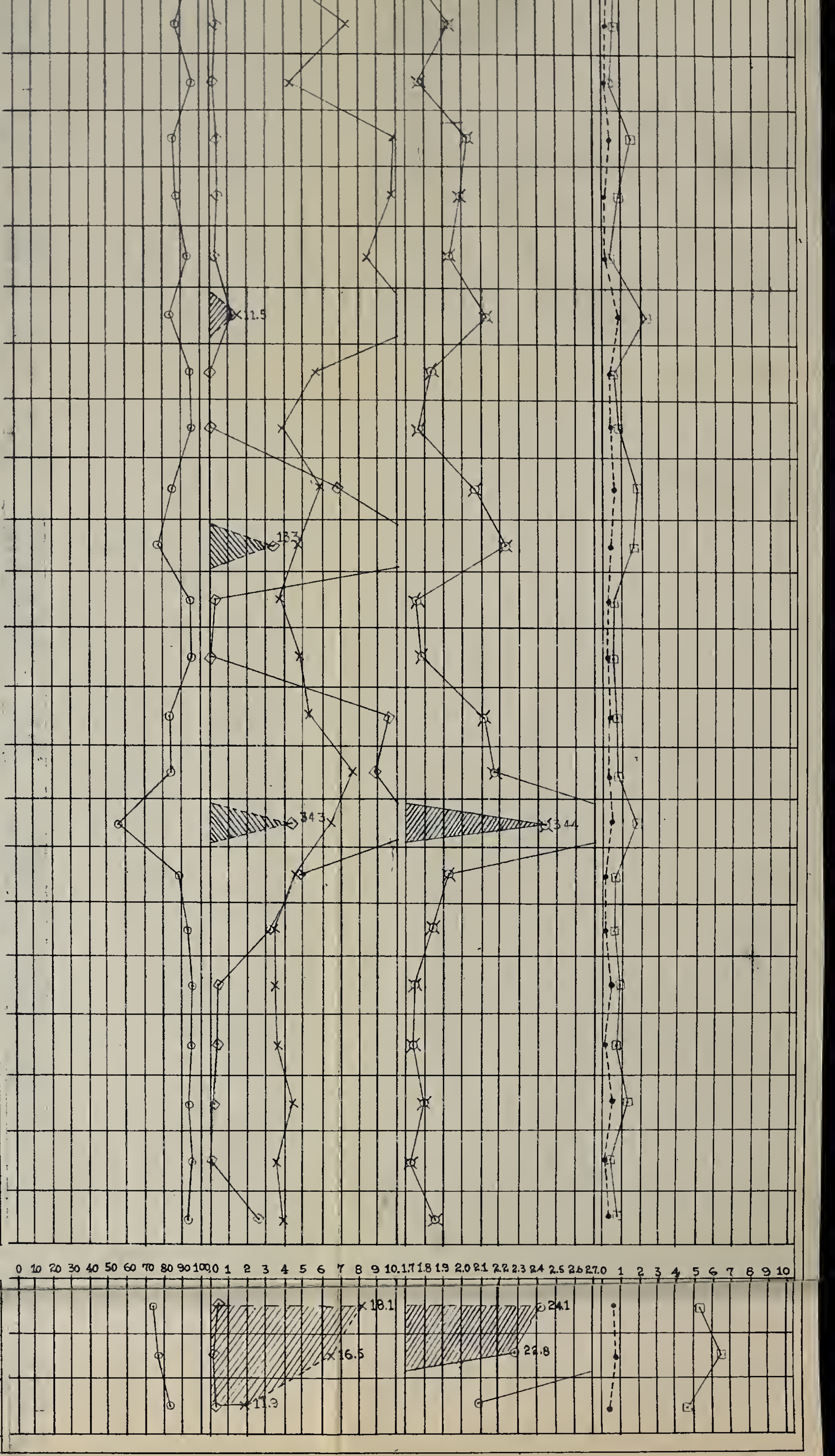
Extensive crystal growths indicate a more advanced stage of recrystallization. Differential solution is slight.

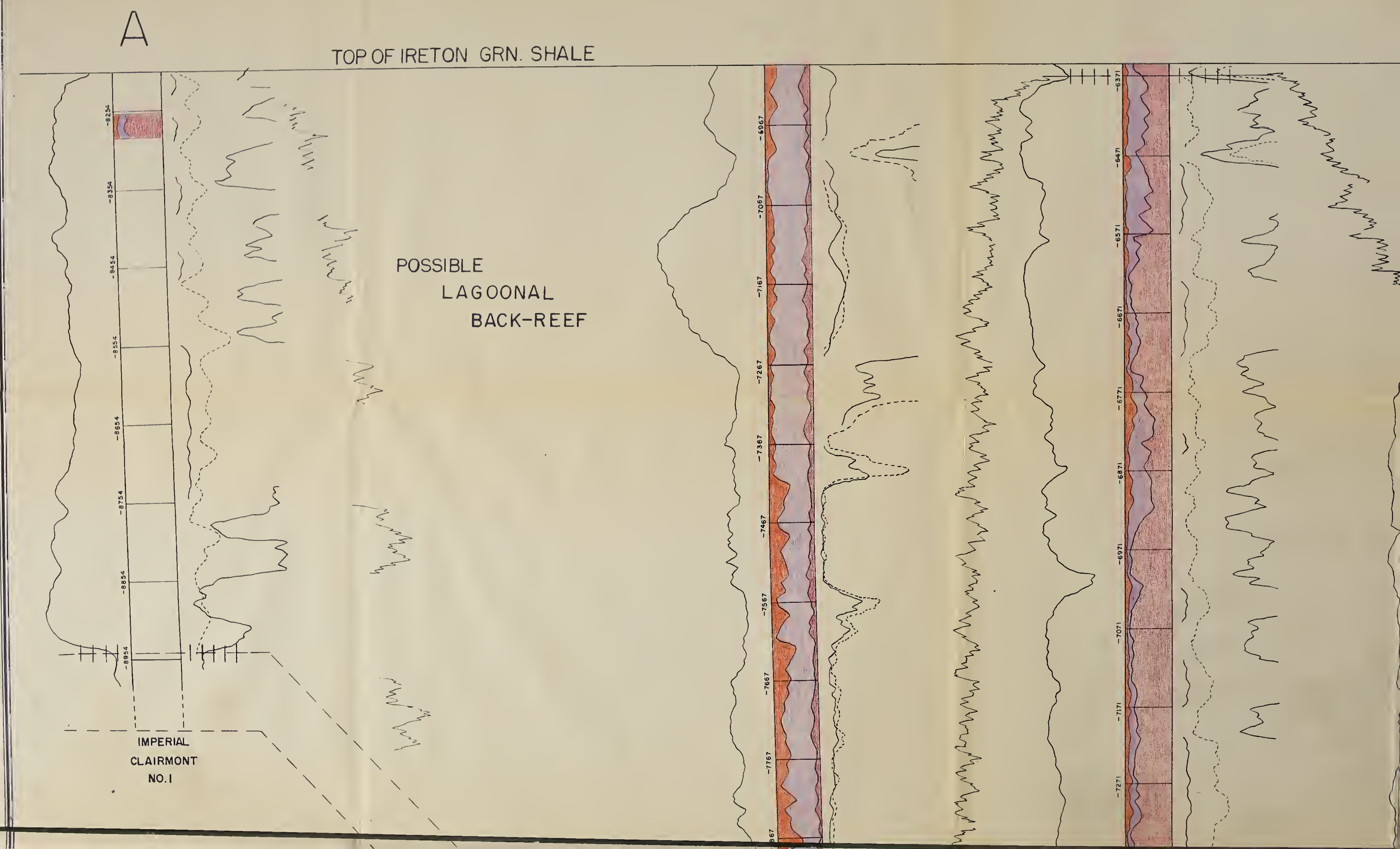
Allogenic silt is prominent as both interstitial and crystal inclusions also increase in included quartz and organic debris.

Rude bedding and varved appearance may indicate lagoonal conditions; lacks textures and structures of reefoid complexes.

Although the effects of compaction are apparent in the origin of the bedding, tight, recryst. text. gen. absent.

Although matrix is well developed, differential solution effects in the dolomite aggregates are only slight.

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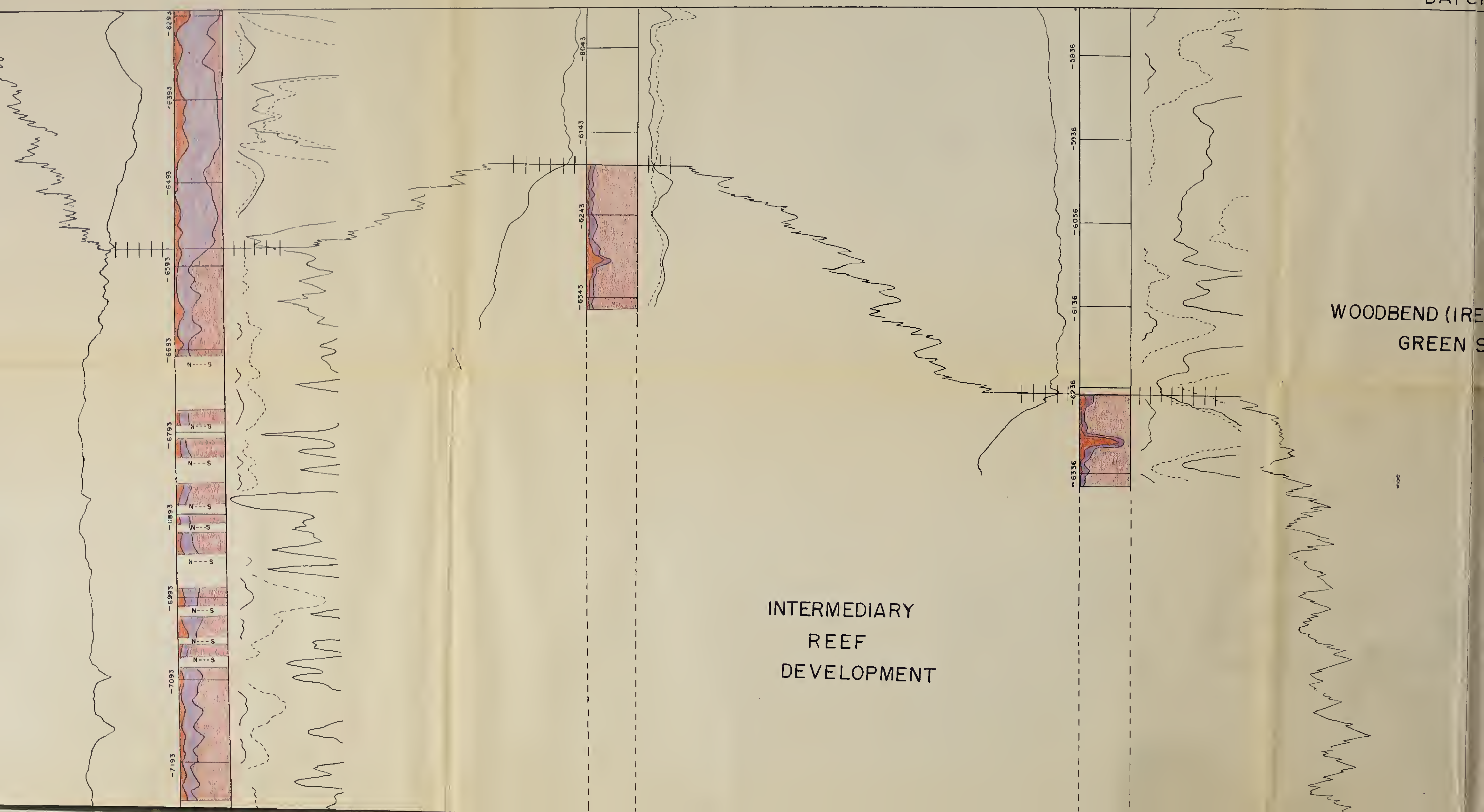
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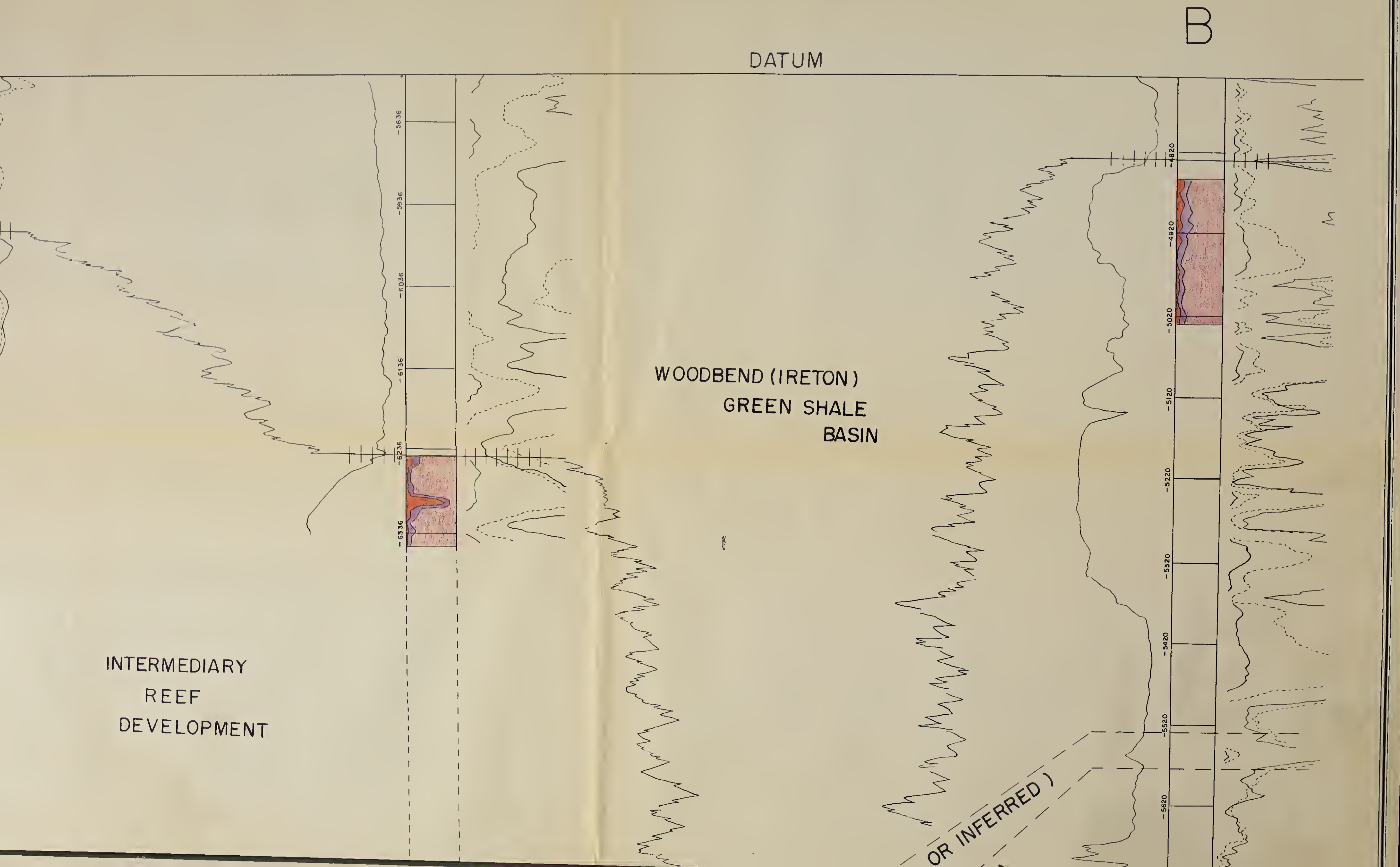
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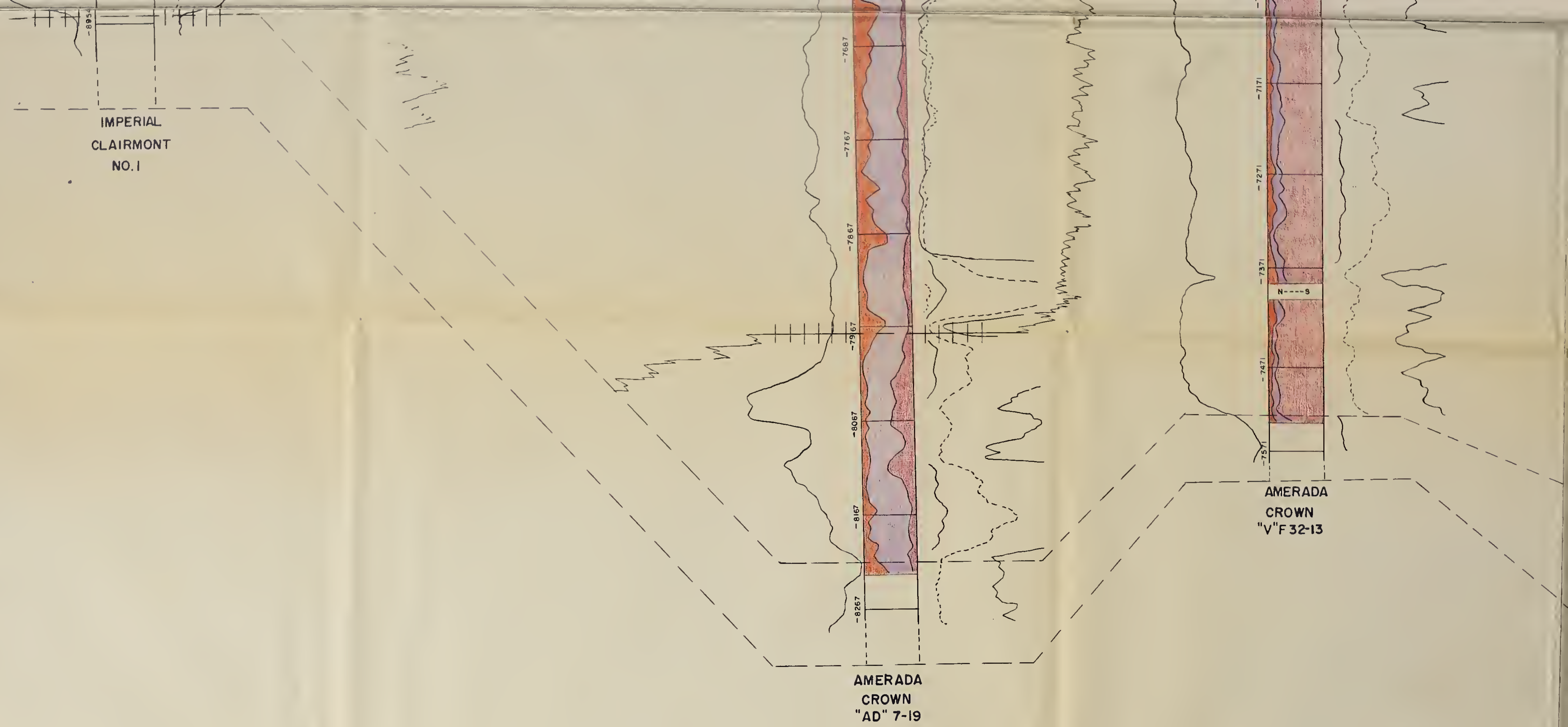
OR INFERRED)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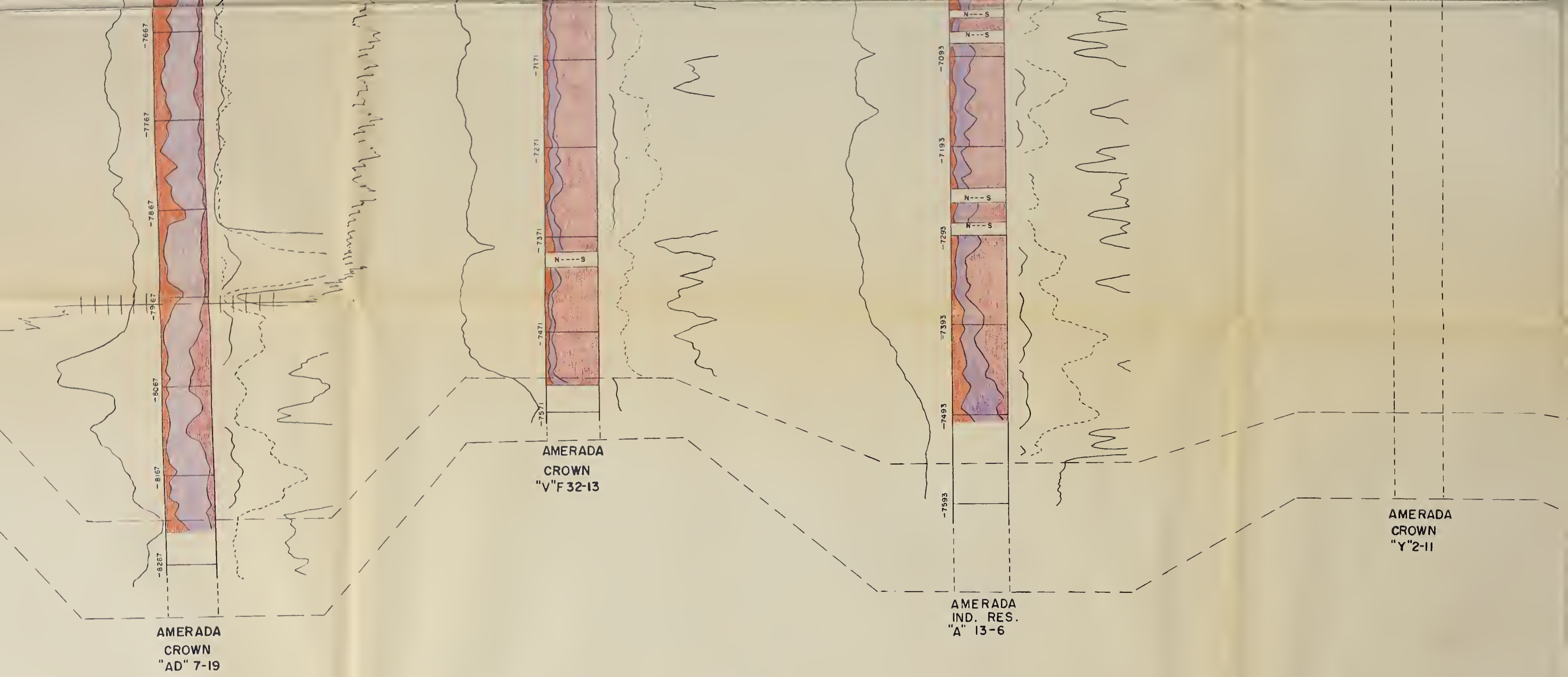


CROSS SECTION: CLAIR MONT - STURGEON
LAKE - NORMANDVILLE

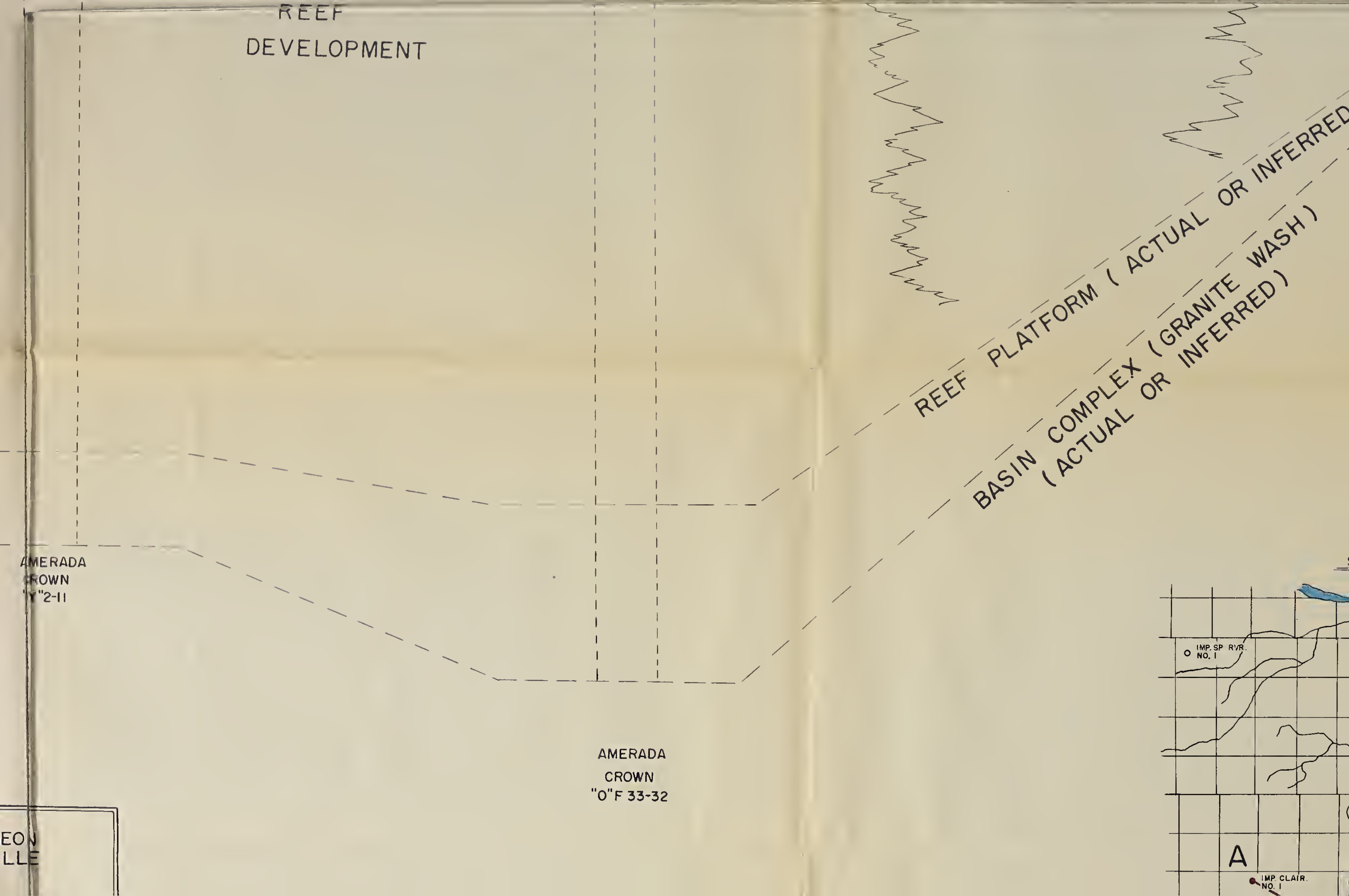
SHOWING REEF DEVELOPMENT ON THE
COOKING LAKE - BEAVERHILL LAKE (EQUIV.) PLATFORM
IN THE WOODBEND (IRETON) GREEN SHALE BASIN.
DEPTH TRACK = CHEM. COMP. (PERCENT)

DATUM: TOP OF IRETON GREEN SHALE

SCALE:
VERTICAL: 1 IN. = 100'
HORIZONTAL: 1 IN. = 16 M.

LEGEND
DOLOMITE ---------- 🟥
LIMESTONE ---------- 🟪
INSOLUBLE RES. ---- 🟧

G.A. LESLIE
APRIL ·2, 1955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